Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

The 2nd Milky Way Meeting

SCIENCE SERVING THE INDUSTRY

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Welcoming remarks

Jacques Surprenant
Director, Dairy and Swine Research and Development Centre, Lennoxville, Quebec

Good afternoon!

It gives me great pleasure to open this second meeting of the Milky Way. This meeting offers a unique opportunity to talk about milk production and, more specifically, about the recent developments in research in this area.

Why talk about research? Simply put, because research is essential for the maintenance and improvement of our competitive position. In fact, it is so essential that we are going to talk about research today and tomorrow. Several studies have shown that for each dollar invested in research by producers, there is a return of ten dollars.

Milk production is by far the largest sector of agricultural production in Canada. The combined value of producing and processing milk products is the envy of all other areas of agricultural production together.

Do you believe that the Canadian milk industry is in great shape, that it is extremely competitive and that therefore, it has nothing to fear from its competitors? If that is what you believe, you have most likely been snoozing over the past few years. At the dawn of the third millennium, it is becoming obvious that competition in this one-market economy will only intensify. The attacks will come from many directions, from today's friends as well as yesterday's allies.

Our marketing structures, our production management systems, our environmental practices and even the way we treat our animals will come under attack. I will not try to convince you that research is the solution to all of these problems; it is not. But research is, without a doubt, one of the major factors that will allow us to ensure the competitiveness of our industry. Research will also allow us to respond to numerous attempts at establishing non-tariff barriers.

Research is a fascinating enterprise. It expands the limits of our imagination, allows us to see farther and prepare a better future for ourselves. I am sure that the researchers invited to attend this meeting will be happy to present the results of their work. If you have a few minutes, get them to tell you about it. You will immediately see what it means to be passionate about what you do. Should there be something you do not understand, please do not hesitate to ask. The researchers are here to answer your questions. If there is not enough time to voice your questions during the presentation, do not hesitate to ask the speaker to give you more information afterwards.

It is easy to see that the next two days will be very full. I am certain that you are going to discover solutions to many problems.This meeting promises to be an important one. It will allow researchers, producers, governments, agencies and industry representatives to discuss the topics that will influence their future.

It is again with great pleasure that I would like to welcome you to this second Milky Way Meeting. I am convinced that it will be most productive. Welcome, and have a great meeting!

Dairy Farmers of Canada: involved in research

John Core
President of Dairy Farmers of Canada

Technological improvements and their adoption by dairy farmers have always been at the centre of successful dairy operations in Canada. In order to develop and maintain cost efficient dairy farms under the climatic conditions prevailing in Canada, our dairy producers needed to adapt technologies developed elsewhere in the world and to develop their own technologies in partnership with private and public research organizations. So technology adoption and adaptation is nothing new for us.

Until recently, federal and provincial governments have contributed the major share of the funding for conducting dairy production research across Canada. The governments of other dairy producing countries have also been involved in funding dairy research. Public research funding has always been considered as an activity which is not trade distorting and not subject to any limitation under the World Trade Organization.

In 1995, the federal government decided to reduce significantly the budget that it was investing in dairy production research and created funding programs based on cost sharing. At the onset, Agriculture and Agri-Food Canada (AAFC) programs were strictly limited to research activities located at federal research centres. On the university research side, matching programs were also operational with the Natural Sciences and Engineering Research Council (NSERC).

Canadian dairy farmers felt that poor government support for dairy research was creating an unfair situation relative to producers in other countries receiving proportionally higher levels of support for technological development. The disadvantage was clear with countries competing with Canada for the same markets for dairy products. In 1995-1996, Dairy Farmers of Canada (DFC) examined the possibilities to directly invest in the development of a research program in order to access government funding and to influence, as a full fledge partner, the directions given to research.

In July of 1996, Dairy Farmers of Canada established a dairy production research program. The first principle guiding this program is to support research initiatives that ultimately maximise producer efficiency and profitability and that improve the health of animals and the development of production methods that respect the environment. The second principle is to encourage research initiatives that promote dialogue and co-operation among producers, other industry stakeholders and governments.

The administration of the fund is the responsibility of DFC's Promotion Committee. The Production Executive Scientific Advisory Committee (PESAC) is the committee responsible for selecting research projects financed by dairy producers. It is co-chaired by two members of the DFC Board. PESAC reviews letters of intention as well as full applications and makes a recommendation. The final decision on the choice of research projects to be supported is the responsibility of the Board of Directors of DFC. It is required that a project receives matching to get funded by DFC.

DFC and its member organizations have a long-standing commitment to dairy research and believe that producers, industry and government all have a responsibility to further the research effort to help ensure a viable future for the industry.

After three years of existence, the program has supported over 40 projects all across Canada. One of its achievements is the creation of a communications officer position at Agriculture and Agri-Food Canada's Dairy and Swine R & D Centre in Lennoxville, Quebec. This position will guarantee all Canadian dairy producers fast, priority access to research results.

Numerous other collaborations resulted from DFC investment in research. AAFC and its Lennoxville Research Centre decided to collaborate with universities involved in dairy research by creating research positions at the University of Guelph, at the Nova Scotia Agricultural College and at Université Laval. This decision allows for a more flexible use of the Matching Investment Initiative program.

In another area, AAFC's Research Branch decided to address the issue of genetic improvement research by accepting contractual research arrangements with private industries involved in dairy cattle breeding and in milk recording. These arrangements allowed both DFC and AAFC to deliver the agreement on mutual support of genetic improvement research signed at the time of the privatization of the genetic improvement and milk recording programs in 1995. Under this scheme, AAFC and the dairy breeding industry support many large research projects. Besides these research activities, the dairy cattle breeding industry has traditionally invested in research projects using a competitive process. During last year, DFC and the Canadian Dairy Network came to an agreement by which DFC administers DairyGen on behalf of the dairy cattle breeding industry. The process is similar to the one followed by DFC with PESAC.

These accomplishments are a few examples of collaboration that were made possible by DFC investing directly in dairy production research. DFC became a player and along with the other players, it is allowed to sit at the table and to decide on the course of the events that should be followed in dairy production research in Canada.

Today's symposium is one of the results of this partnership. The presentations are dealing with research results that were generated by projects jointly financed by farmers organizations and government programs. The intent of this symposium is to communicate to producers the information that was generated by those research projects.

I am confident that this forum will be a successful one in reinforcing the communication between researchers and producers and that it is one of many activities aimed at making the best technology available to Canadian dairy producers.

I am very interested in your comments and I wish all of us a very successful meeting.

Dietary fatty acids and dairy cow reproduction

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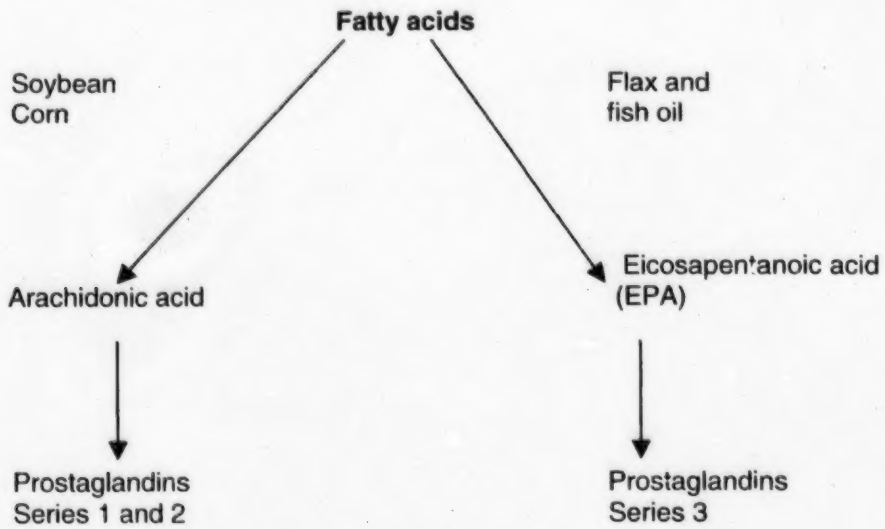
Concerns regarding human consumption of milk products have been raised in the last few years. Milk fat has been criticized because it contains more saturated fatty acids (FA) and less polyunsaturated fatty acids (PUFA) than vegetable fat or fish oil. Intake of saturated FA has been linked to increased risks of heart attack and cardiovascular disease while intake of PUFA has been associated with decreased cholesterol and less heart problems. As a result, animal nutritionists began to feed cows with PUFA protected against any attack by rumen microbes in order to modify milk FA composition. For example, feeding PUFA such as linolenic acid has increased the proportion of omega-3 FA in milk fat (see review by Kennelly, 1996), which answers to guidelines for human health. However, there is little information on the effects of dietary fatty acids on the reproduction of the dairy cow even though we know that cows fed supplemental fat may experience improved energy balance and begin to cycle sooner because of enhanced follicular growth and development (Grummer and Carroll, 1991).

Prostaglandin secretion

What is the relationship between nutrition and reproduction? Prostaglandins (PG) are active substances synthesized from dietary fat and involved in reproduction. There are two main pathways (Figure 1) used to synthesize PG: one is used by most dietary fat (e. g. corn and soybean, sources of omega-6 FA) and leads to series 1 and 2 PG while the other one is more specific to fish products and flax (sources of omega-3 FA) and leads to series 3 PG. Thus, depending on the pathway used for PG synthesis, the type and role of the resulting PG will differ. PG of series 2 are important at calving, while the roles of PG series 1 and 3 remain to be defined.

Figure 1. Pathways for prostaglandin synthesis



Effects of polyunsaturated fatty acids on reproduction

Potential mechanisms by which supplemental fat may improve reproductive performance include stimulation of PG synthesis and secretion and enhanced utilization of blood cholesterol for progesterone synthesis. Days between calving and first ovulation in dairy cattle have been related to energy balance during the first three weeks postpartum. However, Lucy *et al.* (1992) have shown that FA, and not additional energy provided by the FA, stimulate the ovary and cause the development of large follicles. Fatty acid composition of the cell wall membrane is modified by dietary FA (Thatcher *et al.*, 1994). This would alter the function of reproductive tissues. For example, fish oil delays the onset of first ovulation in female rats (Zhao *et al.*, 1992). These results suggest that FA from different metabolic pathways have different effects on reproduction although there is little published information on the effects of FA on the fertility of the dairy cow.

In a project carried out in collaboration with the Institute of Grassland and Environmental Research in the U. K., we verified if dairy cows reproduction was affected by the type of fatty acids incorporated in the diet, if these use two different metabolic pathways. A total of 35 dairy cows were fed from week 10 to 20 of lactation either Megalac or formaldehyde-treated flax as the main fat source. Diets were equal in protein, energy, and fat, and based on a 80 to 20 ratio of ryegrass silage to concentrate. Gestation rate at first AI was 59% for cows fed Megalac compared to 89% for those fed flax, indicating that the type of dietary fat has an important effect on reproduction (Petit *et al.*, 1998).

Forages could also affect reproduction. Chassagne and Barnouin (1992) reported that cows fed grass silage had lower blood PG concentrations than those fed corn silage. Grass silage had greater concentration of linolenic acid and lower concentration of linoleic acid than corn silage. As a result, the incidence of retained placenta in cows fed grass silage was higher than in cows fed corn silage. As linolenic acid is an inhibitor of PG secretion, a high linolenic to linoleic acid ratio (grass silage) therefore could result in retained placenta. This would suggest that fatty acid composition of forages could have important effects on cow reproduction.

Work in progress

A project has been carried out by the Atlantic Dairy and Forage Institute of Fredericton Junction, NB and the Dairy and Swine Research and Development Centre of Lennoxville, Quebec, to improve the reproduction of dairy cows fed different dietary fat sources. A total of 90 cows were fed one of the following three fat sources: Megalac, micronized soybean, and whole flax. All total mixed diets were equal in protein, energy, and fat, and they were based on grass and corn silages. There were 45 cows at each site. Megalac and soybean use the same pathway to synthesize PG while flax uses the other one. We recorded the following reproduction parameters: gestation rate at first, second, and third AI, cycle length, PG synthesis, follicular development, embryo mortality, and progesterone in milk. Production data were also measured: milk production and composition, feed intake, digestibility, and blood composition. All data are being analyzed as we speak.

Another project should be carried out in the year 2000 by the Atlantic Dairy and Forage Institute, Alfred College, Ontario, and the Dairy and Swine Research and Development Centre. This project will look at the effect of feeding different types of fatty acids on the reproduction and the immune response of the dairy cow. Dietary fat is used to synthesize the factors in charge of preventing and fighting disease. As discussed for PG synthesis, the efficiency of these factors will differ according to the pathway used for their synthesis. The ultimate goal is to improve reproduction and immunity of the dairy cow by a better feeding strategy.

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About the speaker

Dr. Petit obtained her Ph.D. in Animal Nutrition from Laval University, in collaboration with the Centre for Food and Animal Research in Ottawa. She is now a researcher with Agriculture and Agri-Food Canada in Lennoxville, Quebec. Her research effort has been divided between basic studies in digestive physiology and utilization of high quality forages by ruminants. She was at the Lennoxville Dairy and Swine Research and Development Centre from 1987 to 1991 where she carried out studies on beef and dairy cattle. In January 1992, Dr. Petit moved to La Pocatière, east of Quebec City, where her research was focused on sheep nutrition. In October 1996 Dr. Petit went to the U.K. for a year where she studied the effect of nutrition on the reproduction of the dairy cow. She came back to Lennoxville R & D Centre two years ago. She is now involved in dairy research. She has authored or co-authored over fifty scientific publications. She is group leader for the dairy section at the Lennoxville R & D Centre and associate editor for the Canadian Journal of Animal Science.

Contribution of forage nitrogen in ruminant nutrition

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Introduction

Nitrogen is the most costly of the major nutrients contained in ruminants' feed rations. It is essential to maintaining the animals' health and to milk secretion, as well as to the production of meat and wool. Forage represents an economical source of nutrients, including nitrogen, for agricultural producers. It can be made up of fresh materials, dry hay or silage. In Quebec and Ontario, more than 80% of dairy producers use grass silage in their feed rations (Lefebvre *et al.*, 1995; OMAFRA, personal communication). What are, therefore, the effects of the nitrogen supplied by the grass silage on the digestive system's metabolism? Can we improve the use of the ingested nitrogen and thereby reduce its waste? These are the aspects of nitrogen metabolism that will be discussed here.

Silage and the rumen

To facilitate the study of forage nitrogen, we can divide this nutrient into three categories: 1) proteins, 2) ammonia 3) peptides and amino acids. During the fermentation process of the silage, a high proportion of protein will be split up into nitrogen compounds of lower molecular weight, either into peptides and amino acids or into ammonia (Table 1). Since nitrogen is now present in different forms, it will go through multiple metabolic pathways in the animal (Figure 1). This brings researchers to study the mechanisms involved in the use of nitrogen, with the purpose of optimizing its use. In general, digestion of protein nitrogen within the rumen will be determined by the resistance of the protein to microbial attacks. On the other hand, ammonia (NH_3) will be rapidly used by the micro-organisms of the rumen if there is enough energy available and if the availability of these two nutrients is well synchronized. If not, an important fraction of the ammonia will be absorbed through the rumen wall, which represents a loss in digestive effectiveness. The third fraction, peptides and amino acids, will generally be used by the micro-organisms or expelled toward the digestive tract downstream from the rumen. As we can see, the proportions of each of the forms of nitrogen will influence the rumen's metabolism, which will in turn have repercussions on the entire animal.

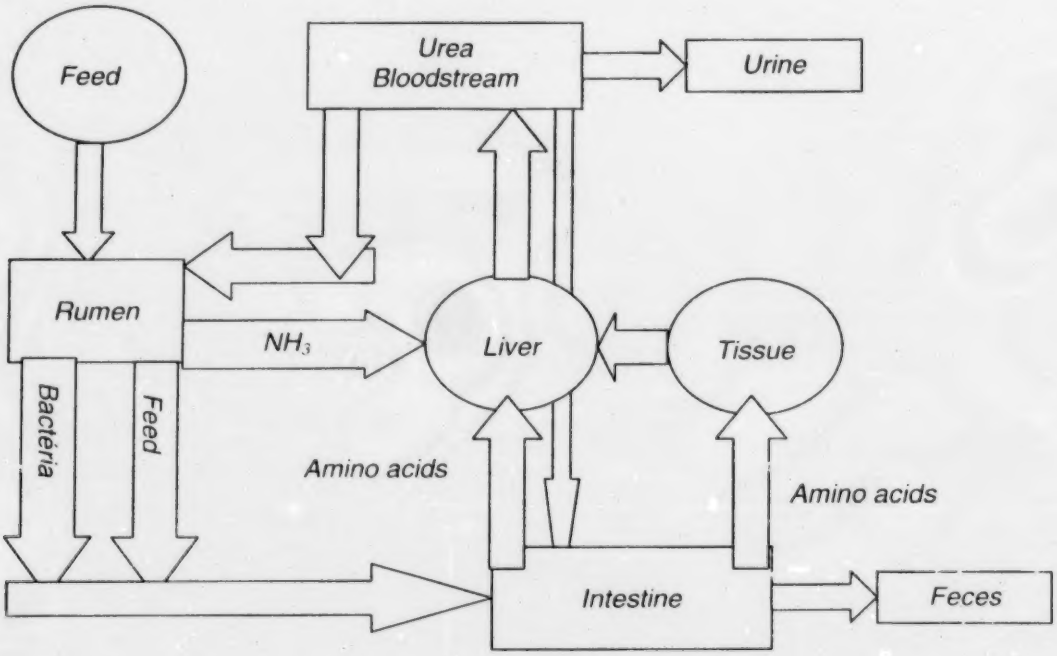
Table 1. Average distribution of forage nitrogen (% of total nitrogen).

	% protein-N	% ammonia-N	% peptide- and amino acid-N
Pasture	75-90	< 1. 5	10-25
Hay	60-85	-----	15-30
Silage	30-45	5-15	45-70

(Woolford, 1984; Petit and Flipot, 1992; Van Soest, 1994).

In ruminants, apparent digestibility of nitrogen is approximately 66% and varies according to the nature of the ration and the animal's physiological state (NRC, 1984). This means that a ruminant that consumes 400 g of nitrogen per day will use or "metabolize" 260 to 280 g per day.

Figure 1. Schematic representation of the major nitrogen pathways in ruminants (Adapted from Van Soest, 1994).



Beyond the rumen

Because of its anatomical position, the digestive system is the first user of the nutrients provided by the rations. Amino acids are absorbed by the small intestine and transported mainly to the liver through the portal vein. However, two teams of researchers have noted that the blood that takes up the absorbed amino acids contain more amino acids than the blood that ends up in the liver. If we compare this to sugar-maple tubing, it is as if the maple sap contained more sugar when it came out of the maples than when it arrived at the shack. Tagari and Bergman (1978) suggested that the digestive system used 30% to 80% of amino acids absorbed. According to them, these amino acids are preferentially transformed or consumed when they pass through the intestinal wall. It is somewhat similar to the spiles consuming a part of the sugar in order to work. More recent research done by MacRae *et al.* (1997) suggests a more precise utilization of amino acids by the digestive system (approximately 60%). However, according to this research, the use of the amino acids by the digestive system would occur mainly in the cow's four stomachs (rumen, reticulum, omasum and abomasum). This creates an influx of blood containing few amino acids, which dilutes the blood circulating between the intestines and the liver. Pursuing our comparison with the sugar-maple industry, it is as if your neighbour was

hooked up to your tubing and ran your maple sap through an osmosis system and returned pure water to your system. The neighbour, in the case of the digestive system, is the cow's stomach.

Research done at the Dairy and Swine Research and Development Centre in Lennoxville shows than in growing steers fed grass silage, more than 66% of the nitrogen reaches the liver in the form of ammonia (Ouellet, 1994). In addition, this study shows that the liver can completely convert this ammonia into urea. This transformation into urea penalizes the animal in two ways. First of all, the formation of a urea molecule requires energy. In fact, this represents 7% of the energy used by the liver (McBride and Kelly, 1990). Secondly, this mechanism consumes amino acids. It has been demonstrated that certain amino acids are used preferentially to supply the second nitrogen atom required to create urea, the first nitrogen atom coming from ammonia (Lobley *et al.*, 1995; Mutsvangwa *et al.*, 1997). These amino acids, which will have served to produce urea, will no longer be available for dairy production or foetus formation. The quantity of ammonia produced must therefore be limited in order to reduce the energy consumed and eliminate the loss of amino acids. A judicious choice of forage and adequate silage making techniques, a short wilting period and a quick reduction of the pH level reduce the proteolysis of nitrogen and improve the animal's performance (for more details, see Lafrenière *et al.*, 1998). The use of supplements that are relatively resistant to rumen degradation or of amino acids protected against rumen degradation are examples of techniques that, in some circumstances, can help improve the use of dietary nitrogen. (Ouellet, 1994; Blouin *et al.*, 1995). At times, good synchronisation between the availability of ammonia and carbohydrates in the rumen is conducive to microbial synthesis and reduces the waste of ammonia (Kolver *et al.*, 1998).

Recycling of nitrogen

The urea produced by the liver is eliminated, in great part, in the urine (Huntington, 1989). This loss represents approximately 30% of the nitrogen consumed (Ouellet, 1994; Petit *et al.*, 1997). If we take into account the 66% apparent digestibility previously mentioned, final analysis shows that only 35% of the nitrogen consumed can be useful to the animal and to production. Moreover, urinary and faecal losses account for important quantities of nitrogen that damage the environment and that must be reduced to a minimum.

To this end, ruminants possess a mechanism that nutritionists can make use of, which is the recycling of urea. It has been shown that this recycling is greater when the ration contains less nitrogen. Urea recycling is done through saliva and the wall of the rumen or of the intestine (Nolan, 1974). Scientists observed, when giving animals rations rich in alfalfa, that the return of nitrogen was effected mainly in gastro-intestinal tissues (Huntington, 1989). On the other hand, rations that contain a high quantity of concentrates bring about the return of nitrogen through the saliva and the wall of the rumen (Huntington, 1989). The fact that mechanisms exist to recuperate a portion of the nitrogen through various pathways shows that it would be possible to work on this aspect of nitrogen metabolism in order to improve its use.

Conclusion

Ruminants have the capacity to maximize the use of forage through the action of the micro-organisms found in the rumen. Nitrogen plays an essential role in the growth of micro-organisms. However, the forms in which we find nitrogen contained in forage will determine its use. Apparent digestibility shows that a significant portion of the nitrogen that reaches the intestine is lost in the feces. Moreover, grass silage contains a very high level of non-protein nitrogen that will be mostly absorbed by the wall of the rumen and will make its way to the liver, where it will be converted into urea. Urea formation requires energy and consumes amino acids.

Although a nitrogen recycling process exists, these urea molecules will in great part be excreted in the urine, which reduces the effectiveness of the use of nitrogen and increases pollution.

Adequate management during ensiling will reduce proteolysis. The addition of amino acid supplements protected against degradation in the rumen or a better capacity to meet the animals' specific needs through the formulation of the rations can reduce nitrogen wastage. It is, moreover, possible to improve the use of the nitrogen components by controlling or manipulating the nitrogen's metabolism in the liver and the intestines.

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About the speaker

Dr. Ouellet obtained his Ph.D. in Animal Science from Laval University, in Quebec City, in 1994. The next year, he was doing postdoctoral sudies at New England University in Australia in order to acquire additional knowledge on nitrogen metabolism in ruminants. Since 1994, he has been a research scientist in ruminant nutrition and metabolism at Agriculture and Agri-Food Canada's Dairy and Swine Research and Development Centre in Lennoxville. His research interests aim at improving forage use, including pastures, by ruminants. He studied the estimation of energy value of forages. His work also measures nitrogen and hormonal transactions in the digestive track and the liver. Dr. Ouellet works with his collaborators to develop and introduce novel ingredients in ruminant rations in order to improve their performance and reduce nitrogen losses.

Biotechnology serving dairy production

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The success of the dairy industry in Canada is impressive and largely due to its foundation as a knowledge and science-based industry that stays on the cutting edge of technological innovation. In the face of globalization however, and the resulting open markets for milk and milk products, the industry is undergoing considerable change. Despite the uncertainties associated with change, there is ample reason to believe that our industry can and will remain competitive. In this regard, remarkable new research and development opportunities are offered by the application of new biotechnologies and there is no doubt that they will have a very positive impact on future research and development in support of Canada's dairy industry.

Canada's position as a world leader in biotechnology, both in its quality of science and science infrastructure, provides fertile ground for dairy biotechnology research and development. Through the application of biotechnologies, dairy researchers are increasingly engaging in interdisciplinary approaches to provide new knowledge and solutions to the industry they serve. This emerging trend offers enormous opportunity for discovery and invention. It cannot be understated however, that transforming knowledge from such cutting edge research into solutions for the industry will remain a critical component for future business success in Canada's dairy industry. That challenge aside, it is the intent of the present overview of the potential of biotechnologies to benefit dairy production to reveal that there will be no lack of excitement in dairy science as we begin the new millennium.

Biotechnology – a definition

Biotechnology is an umbrella term, covering a broad spectrum of scientific applications used in many disciplines. The Federal government defines biotechnology as « the application of science and engineering in the direct or indirect use of living organisms, or parts or products of living organisms, in their natural or modified forms». The Canadian Biotechnology Strategy refers to biotechnology as a powerful "enabling technology" with applications in many sectors and holding much promise for the future. Agricultural biotechnology is therefore the application of these new molecular-based technologies with an overall goal to benefit producers, processors, and consumers of agricultural products. In the dairy production sector, the benefits of biotechnologies will be realized through enhanced efficiency and sustainability of production, as well as further improvement of animal welfare. There are also expectations for improvements in disease diagnosis and treatment, especially mastitis, as well as further improvement in other traits such as reproductive performance.

Functional genomics and bioinformatics

It is difficult to talk about biotechnologies, let alone provide a vision for their potential to benefit industry, without reference to one of their most remarkable qualities - their rapid evolution. The explosive growth of biotechnologies is driven by supporting research platforms that seem to be improving with no end in sight. Indeed, the last decade or so of research into genes and how the genome performs its business has led to a revolution in genomics research. In turn, that growth has spawned a new and perhaps even more rapidly emerging scientific field called functional genomics. The revolution has certainly changed the way in which we think about biological research and will underpin most if not all of tomorrow's biotechnologies, including those that will be applied in dairy production research.

Functional genomics refers to comprehensive molecular analysis, in which the functions of individual genes are studied within the context of all the genes in a cell and, ultimately, at the level of the whole organism. Unimaginable even 5 years ago, it has recently become possible to study the expression of thousands of genes simultaneously using new expression genetics technologies. Other powerful new technologies are expressed sequence tag (EST) technologies, used to identify previously unknown genes, and DNA chip technologies, which are proving useful for a diverse range of applications from detection of SNPs (pronounced «snips»), which stands for single nucleotide polymorphism, and gene expression analysis to rapid genetic linkage analysis. Applicable in research with any species, these new technologies allow sophisticated research that generates volumes of information and data of a scale that has driven the development of yet another new field called bioinformatics.

Bioinformatics goes beyond simple data management, seeking to provide tools for analyzing multidimensional information that comes from global analysis of gene expression and its relationship to protein structure and function. The daunting nature of such large-scale data generation was discussed in the inaugural issue of the new journal *Physiological Genomics*. It was pointed out that an experiment using 300 mice to look at the expression of only 200 genes results in the generation of more than 15,000,000 data points. Similarly, the completion of DNA sequencing in the Human Genome Project over the next few years will yield information from the human genome's nearly 3.5 billion base pairs and 75,000 to 100,000 genes. The management of this amount of data presents us with an enormous challenge. Though complete sequencing of the genomes of agricultural species, including the bovine, is not yet feasible, exploitation of information in the human genome data base through the application of bioinformatic strategies by dairy scientists holds great promise to benefit the dairy industry.

Another large-scale genome initiative is aimed at creating a genome wide catalog of human DNA variation (i.e., SNPs). Though this polymorphism data would be more valuable if it were linked to detailed biological information, private companies are sponsoring big research projects, mostly based on the use of DNA chip technology, to scan the genome, identify SNPs, and patent them. Many biotech companies are jumping into the race to develop SNP-hunting systems and, of course, the SNP race as well. The development of new technologies to more efficiently identify SNPs will be of immediate benefit to the dairy research community. The potential value of discovering SNPs in the bovine genome, particularly in genes responsible for traits of economic importance, has driven increased industry investment in bovine genomics research.

Biotechnology serving dairy production

Though all the tools of biotechnology are not yet routinely available to dairy scientists, a new vision for dairy research that includes biotechnologies is already being established as a key underpinning for dairy research in Canada in the 21st century. Dairy researchers across the country are increasingly integrating biotechnologies into their research programs and, as a result, more frequently engaging in valuable interdisciplinary collaborations. Our dairy research group has been applying molecular-based research strategies to address biological questions in dairy production for more than ten years. Capitalizing on our leading position in gene analysis, we are well positioned to continue expanding the scope and depth of our biotechnology-based dairy research program. To that end, we have stayed at the cutting edge by adopting sophisticated and powerful new technologies into our research program. We recognized the enormous potential of expression genetics technology when it first came on the scene several years ago and integrated the technology into our research program. We have applied it in projects to study the physiology of lactating mammary epithelial cells and the mechanisms regulating feed intake in dairy cattle.

In the feed intake project we are analyzing the simultaneous expression of all the genes expressed in epithelial cells in the small intestine (duodenum) of dairy cattle that have been fasted and then re-fed. Thus, for the first time, through the application of this powerful biotechnology, we are able to analyze the genetic changes in bovine intestinal cells with a goal to discover new genes involved in controlling feed intake. We also continue to incorporate improvements as the technology rapidly grows and matures. Each experimental run currently allows the simultaneous analysis of the expression status of approximately 4,500 genes. So far we have identified over 30 genes of interest that are currently at various stages of characterization. Not surprisingly, it turns out that most of the genes that we have identified as possible players in controlling hunger or satiety are new genes that have never before been identified through DNA sequencing or other methods of characterization.

Another of our research projects, designed to complement our search for genes of economic importance to the dairy industry, has involved the application of biotechnology to commercialize milk protein genotyping. With multiple component pricing of milk now in place, the time has arrived to at least begin to incorporate genetic information relevant to milk composition into the criteria used to make breeding decisions. The ultimate goal of our genotyping project is to put in place our genotyping technology and the necessary infrastructure for large scale, routine genotyping of cows and replacement heifers in the Canadian dairy industry.

In summary, there is an increasing use of biotechnologies in dairy research programs in support of the dairy industry in Canada. The major attraction of these new and powerful technologies is the enormous opportunity that they offer for discovery and the acquisition of new knowledge. There is little doubt that such new knowledge will be required to meet the needs for technological innovation in the Canadian dairy industry in the 21st century.

About the speaker

Dr. Glimm received, in 1985, Bachelor of Science degree in Agriculture with a Major in Animal Science. In 1990 he received his Ph.D. in Animal Biochemistry from University of Alberta. His Ph.D. research involved the application of molecular biology techniques to address a fundamental question in lactation biology: how does growth hormone stimulate lactation, or more precisely, how does it stimulate mammary cells to synthesize and secrete more milk?

David then accepted an Industrial Research Fellowship from NSERC to work in a joint appointment with the Alberta Dairy Association Research Unit and as a member of the Dairy Research Group at the University of Alberta.

After completing the NSERC Fellowship, David was appointed as a Research Associate in the Dairy Group at the U of A, where he is presently employed.

David's research and collaborative projects involve the application of biotechnologies in dairy production research with the goal to benefit the dairy industry.

Modified milk that will save lives

François Pothier
Full professor, Department of Animal Science, Laval University, Quebec City

The domestication of animals, often accompanied by changes in form and function, has been a part of our culture for thousands of years. Human activity in the area of animal genetics has not only led to positive contributions in certain areas of animal science; it has also brought about an increase in animal diversity by producing animals that would otherwise never have existed. The genetic selection processes that have been practised for many decades are now being increasingly supported by new molecular approaches allowing the analysis of genes that can be used for different applications and the acceleration of genetic improvements. In the midst of a great number of biotechnological innovations, transgenesis has established itself as a powerful technique used to modify an animal's phenotype.

By definition, a transgenic animal is an animal that carries in its genetic material a new gene introduced by man. It could in some ways be described as a tailor-made animal. Because the foreign gene is introduced during the very early stages of embryonic development, it permeates the animal's cells and can be transmitted to its progeny. Although transgenesis was first used in mice to develop models for studying human diseases (cancer, AIDS, Alzheimer's), scientists soon tried to transfer genes of specific interest to domestic species.

The first transgenic pig was born in 1985 in the United States. A gene was produced in the laboratory to allow over-expression of the growth hormone in this species. This gene significantly reduced total fat quantity, increased growth by 17% and promoted better use of feed. The first transgenic cow, engineered at the beginning of the 1990s, was born in Holland. This cow synthesizes human lactoferrin in its milk. This protein, which binds iron and is almost absent in cow's milk, is required to protect human infants against gastrointestinal infections. This transgenic cow now offers milk that is a little closer to human mothers' milk. The great similarity between certain DNA sequences in different animal species explains the success of these genetic transfers. Despite technical obstacles, more than fifty transgenic domestic animals carrying various transgenes have been produced to date.

Transgenesis, as opposed to traditional genetic selection techniques that allow the practically uncontrollable transmission of many genes at the same time, allows the modification of one gene at a time. The resulting animals can then be crossed with different breeds without the new transgenic character being impaired. Great diversity can therefore be preserved among reproducing animals.

Effectively managing transgene expression

Simply put, a gene is made up of two parts. One part is called the promoter or regulatory element. It allows for the synthesis of the coded protein in the right tissue at the right time. It is the part that directs the other, gives it its starting signal, sets its speed and tells it when to stop. The other part encodes the sequence of amino acids that will create the protein.

Molecular biology allows us to isolate a gene, dissect its parts and reconstruct new genes that do not exist in nature. For example, expression of human protein can be triggered in ewe's milk by binding the regulatory elements of one of the casein genes with the part encoding the human factor. At the time of lactation, the ewe will synthesize, in addition to the various normal components of milk, an additional protein corresponding to the desired human gene. Most of the

regulatory elements in casein genes have been identified and sequenced in cows, ewes and goats. Their effectiveness in managing the expression of foreign protein in milk has been demonstrated in transgenic mice.

The mammary gland as bioreactor

In species such as cows, sheep and goats, the mammary gland is of particular interest for transgenic manipulation. Three types of applications are considered:

1- Modifying the natural composition of milk to adapt it to the needs of the milk processing sector.

2- "Humanising" cow's milk by introducing human proteins or removing undesirable proteins.

3- Using the udder as a bioreactor to synthesize therapeutic proteins for human consumption.

Pharmaceutical companies are particularly interested in this last application. Already, at the beginning of the 1990s, recombinant human insulin was produced with genetically modified bacteria. Like the growth hormone, insulin is a simple molecule that does not need to be transformed after synthesis. Once the human gene is introduced in the bacteria, they will multiply and produce great quantities of hormones at minimal cost. This process does not, however, suit all types of human protein. Certain human factors must be transformed (glycosylated or phosphorylated) in order to become active. The cellular mechanisms of bacteria cannot accomplish such modifications. The gene must therefore be introduced in cells taken from higher organisms than bacteria, eucaryotes. Such reactors were developed during the 1970s. However, the cost of using them is prohibitive. One gram of human protein generated by these bioreactors costs between $2,000 and $3,000.

On the other hand, the mammary gland is a natural bioreactor capable of generating many grams of protein per day. The mechanism is simplified because the only requirement is that the animal be adequately fed. Further, the risks of contamination by human pathogens are practically non-existent. Genzyme Transgenics produced, in 1991, the first transgenic animal that could synthesize a recombinant protein in milk, a goat that secreted a human plasminogen activator (anti-clotting agent). Today, three major companies, Genzyme Transgenics (USA), PPL Therapeutics (England) and Pharming (Holland) use the udders of transgenic animals to synthesize human recombinant proteins. Antithrombin III (an anticoagulant) will be the first pharmaceutical product synthesized in an udder to be marketed in the year 2000. Alpha-antitrypsin (used in the treatment of cystic fibrosis) and fibrinogen will soon thereafter be released by PPL Therapeutics, while Pharming will produce human albumin in cow's milk. Products obtained from transgenic animals cost between $10 and $100 per gram. Although the products mentioned above are already synthesized from cultured cells, the FDA (Food and Drug Administration) has required that they be put through clinical phase testing before being introduced on the market. More than thirty human products will soon be purified from cows', goats' and ewes' milk.

Profits versus ethics

All of these manipulations, even when they have positive outcomes, raise serious fears and concerns in those who see them as the first step towards their application in humans. The biologist regularly finds him or herself in the midst of a great bioethical debate. What are the potential dangers for humans? Does one have the right to patent genes and living creatures? Where do animal rights begin and end? What would be the consequences if one of these altered animals were to escape and the new gene introduced into wild species?

We remain without definite answers. Molecular biology, together with the possibility of manipulating embryos *in vitro*, has pushed back the frontiers of the impossible even before guidelines and laws have been established. Discussions among philosophers, sociologists, scientists, politicians and legal experts have barely begun while genes and transgenic animals have already been patented all over the world. This reality has led us, for over a year, to characterize genes from the mammary glands of moose, because the corresponding genes in cows are patented and cannot be used for commercial purposes.

From the point of view of animal welfare, transgenic animals are treated in accordance with the recommendations of animal welfare committees. Because of the value of transgenic animals that synthesize human proteins or could become organ donors, we can expect that they will be treated with the highest regard.

But beyond these moral, religious or ethical considerations, the consumer will be the one who will ultimately decide the future of biotechnological products. In this context, it becomes imperative to clearly explain the processes and provide accurate information to consumers concerning the genetic modifications made.

These issues should become the subject of a societal debate that will establish the guidelines to follow as we step into the new millennium.

About the speaker

Dr. Pothier is full professor in the Department of Animal Science at the Faculty of Agricultural and Food Sciences of Laval University in Quebec City. He is a member of the Research Centre on Biology of Reproduction at this University. His research interests include the factors that control the life duration of cells, transgenesis, the functioning of reproductive cells and cancer mechanisms.

Milk enriched with CLA and omega-3: opportunity for the dairy industry?

Alan H. Fredeen
Department of Animal Science, Nova Scotia Agricultural College, Truro

Introduction

Some two and a half millennia since Hippocrates issued the words: "Let your food be your medicine; let your medicine be your food", more than 50 essential nutrients have been identified. The connections between food and health are being discovered. In the last 15 years, for example, we have learned about both the essential and deadly components of fat.

Milk fat contains saturated fatty acids which give it stability on one hand, but are considered a nutritional hazard on the other. In its favour, milk provides all but a few essential nutrients. One of its deficiencies is its lack of the essential fatty acids.

Both CLA and omega-3 fatty acids can be put into milk. Conjugated linoleic acid (CLA) is a fatty acid that has been shown to be a potent cancer fighting agent. The omega-3 fatty acids have been shown to lower blood fat levels and to have a protective function against the reactions in blood that cause stroke or "heart disease". While CLA is present normally in milk, omega-3 fatty acids are not. The dairy industry could make use of the image of milk containing CLA naturally, and it could create omega-3 and CLA-enriched milk.

Synthetic diets and health: the role of milk

Modern diets now include elevated levels of plant oils and margarine, based on advice to avoid cholesterol and saturated fats. The expected benefits of this shift have not materialized. Incidence of chronic disease, "heart disease" and cancer have actually risen, causing an increasing number of experts to believe that eating more butter reduces the incidence of these diseases. Researchers have found that the negative effect of the switch to plant oils is due to the increased presence, in prepared foods, of omega-6 fatty acids, the ubiquitous products of their synthetic hardening and of toxic by-products generated when plant oils are fried.

Concurrently to the increase in the consumption of omega-6 fatty acids, consumption of omega-3 fatty acids has decreased dramatically in Western diets (Table 1). While both omega-3 and omega-6 fatty acids are essential, they have opposite roles and need to be consumed in balanced proportions.

Table 1. Relationship between omega-3 and omega-6 fatty acid intake and cardiovascular mortality.

Diet	% of fatty acids in the diet		Ratio -6/-3	Cardiovascular mortality (%)
	Omega-3	Omega-6		
Western	0. 5	26	50	45
Asian	21	1. 6	12	12
Inuit	8. 3	8	1	7

Essential fatty acids are, among other things, the precursors of prostaglandins (PG) which are internal cell messengers. The omega-6 fatty acid precursor yields prostaglandins which, in

humans, are related to incidence of cancer, arthritis and atherosclerosis. PG produced from omega-3 are not, and furthermore exert an important preventative effect for many degenerative diseases such as arthritis, cancer and strokes. Omega-3 fatty acids are also needed for eye and brain development in early life, and in the function of the immune system.

Various sources recommend a 6:1 or lower dietary ratio of omega-6 to omega-3 fatty acids. Deficiency in omega-3, calculated on the basis of assumed intakes and requirements, is estimated to be high in Western countries. The omega-3 and omega-6 fatty acids content of foods varies considerably (Table 2). It is therefore relatively easy to create a balanced diet.

Table 2. Content of omega-3 and 6 fatty acids in food (% of total fat).

Source	Omega-3	Omega-6	Ratio -6/-3
Mackerel, Atlantic	2. 5	Trace	-
Soybean oil	7. 8	7. 0	0. 9
Safflower	-	75	-
Canola	7	30	4. 3
Flax seed	22. 8	6. 4	0. 3
Butter	Trace	2	-
Margarine, soft	-	27. 1	-
Typical milk	0. 1	Trace	-

People too busy or too neglectful to eat a balanced diet require a supplement. Flax oil, for example is a source of ALA, an omega-3 fatty acid, while fish oils contain EPA and DHA, two other essential fatty acids. Children are among those least likely to consume an oil suppiement or foods containing significant quantities of omega-3. Milk would be a handy vehicle for providing another one of many essential nutrients that a growing child requires. Enrichment of foods is already prevalent in some countries. In South-East Asia, omega-3 fatty acids are added to everything from bread to chewing gum.

Improving the fatty acid profile of milk

Milk typically has no omega-3 fatty acids, unless the cows are receiving a feed, such as flax or fish meal, containing them. Consequently, the ratio of omega-6 to omega-3 fatty acids in milk is normally higher than recommended.

CLA is produced by the rumen microbes from the main fatty acid in plants, linoleic acid. It is then transported to the udder where it gets incorporated in milk fat. CLA in milk was elevated by 237% when cows grazed forage as opposed to having it as silage. Pasture resulted in a doubling of CLA content of milk (from 4.6 to 10.9 mg/g milk fat) in a study by Lough and Anderson, in 1973. Conjugated linoleic acid is a naturally occurring nutrient with strong antioxidant and anti-carcinogenic properties that can be transferred to dairy products.

To enhance milk with desirable fatty acids, these must be protected from the rumen and its microbes. Methods employed to accomplish this go from managing the forage component of the diet (the most natural), to feeding flax seed, directly or after processing. Also, fish oils, which contain DHA and EPA, can be encapsulated to provide protection. Actual transfer rates of fatty acids to milk are dependent on their concentration in the supplement, the extent of protection

against transformation in the rumen, the absorption into blood, metabolic conversion and transfer to milk.

The best source of DHA is alga (it contains 40-50% oil with 40% DHA) in the sense that it is a natural high source of DHA that will not be too prone to oxidation before feeding. Fish oil is another source of DHA. The omega-3 component of fish oil can be concentrated to make an exceptionally rich supplement. Although fish oils are more resistant to ruminal fermentation, encapsulation increases transfer to milk, with less generation of by-product fatty acids in the rumen.

Green grass, with 50-75% omega-3, is cost-effective. Forages are already the centre of most dairy systems. However, they contain LA and ALA, not DHA itself. Forage fatty acids are highest in immature green grass. Wilting and ensiling, drying, cloudy weather and increased maturity will reduce their concentration. Flax seed (with 80% oil containing 80% ALA) is the best source of ALA. It is also somewhat naturally protected. Its high ALA content makes it susceptible to oxidation.

Omega-3 fatty acids and products of fermentation of the polyunsaturated fatty acids also reduce butterfat, an effect that might be beneficial for this particular market. Specific conjugated fatty acids can also be protected for transfer to milk.

Other challenges and opportunities

Omega-3 fatty acids are prone to oxidation, yielding an unacceptable off-flavour. Extreme care is required to avoid oxidation of the fatty acids while storing and feeding the supplement to the cows, milk handling and processing, and milk storage in the store and home. The glitter of enriched milk would fade fast if it had a reputation of having a fishy taste. Milk would need to be handled like a medicine as much as like a food. It would need the protection of an antioxidant, should be prepared in small volumes, packaged in opaque containers under oxygen-limiting conditions, delivered frequently and consumed quickly. It could probably not be used to make butter, ice cream or cheese, because of the greater opportunity for oxidation.

Enriched milk, produced by cows consuming adequate antioxidant to prevent oxidation and stored under optimal conditions, could be a general selling feature. Target markets for enriched milk include the growing percentage of adults that are interested in improving their diets nutritionally and who are already drinking milk with fat in it. This group is also concerned with environmental effects of agriculture and impurities in their food and are also likely trending toward "organically" produced milk. Using a combination of sources, including the forages already present in the diet, and perhaps flax or fish meal, milk could be cost-effectively enriched with ALA, DHA and CLA. An ideal diet for humans should be balanced without supplements or enrichments. Until we get there, milk enriched with CLA and omega-3 fatty acids will be a valuable component of the diet.

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About the speaker

Alan Fredeen received his Ph.D. in 1984 from the University of California, Davis. He joined the Department of Animal Science of the Nova Scotia Agricultural College (NSAC) in 1995 to cover dairy systems and ruminant nutrition research and teaching. He teaches courses in dairy management and nutrition as well as food safety. His research includes developing rumen-protected omega-3 fatty acid and amino acid supplements for dairy cows, systems analysis using computer model of the dairy farm and developing pasture systems for dairy cows. He currently leads a team in charge of developing the Pasture Research Centre at NSAC, and a multidisciplinary team researching sustainable dairy management practices.

Omega-3 eggs: a case study

Daniel Lavoie
Director, Les Œufs Avibro, Sainte-Claire, Quebec

Mr. Lavoie will explain the impact of the development of a very specific niche product on the consumption of a familiar animal product, the egg. He will describe consumers reactions to the introduction of such a product on the market. He will end his presentation by telling us about the economic importance of omega-3 eggs for egg producers.

About the speaker

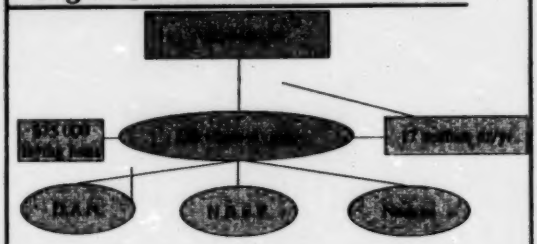
Mr. Daniel Lavoie is responsible for operations of the farms and egg grading facilities and for the sales and marketing of the various egg products for Les Oeufs Avibro and its subsidiaries, Distribution Avicole du Nord Inc. and Northern New Brunswick Egg Producers Inc.

Before that, Mr. Lavoie worked in the mining industry and also in the food industry, with companies such as Nabisco Brands and Hershey Canada. He sits on numerous boards in the poultry sector.

Omega-3 eggs: a case study

Daniel Lavoie, Avibro

Organization Chart



History

- Production
  - 1965 start (20 000)
  - 1982 buy Avibro (100 000)
  - 1988 in line (140 000)
  - 1990 quota (180 000)
  - 1996 in line (186 000)
  - 1998 add (196 000)
  - 1999 in line (200 000)
- Classification
  - 1965 local distribution (300 000 dz)
  - 1978 Fedco (350 000 dz)
  - 1988 Pro-œuf (3 000 000 dz)
  - 1990 Marketing Avibro (5 800 000 dz)
  - 1994 Marketing plan (6 600 000 dz)
  - 1998 Northern New Brunswick (9 000 000 dz)
  - 1999 D. Avicole du Nord (16 000 000 dz)

Les Œufs Avibro
Company Profile

- ***2nd egg producer in Québec***
  200 000 laying hens
- State-of-the-art grading station
- Over 16 000 000 dz per year
- Complete range of specialized products
- Sales force
- Fleet of trucks
- HACCP programme

Territory Covered

- Montreal and area
- Sherbrooke
- Bois-Francs
- Quebec, Beauce, Appalachians
- Lake St-Jean, Saguenay
- Gaspésie, Côte-Nord
- New Brunswick

Food chains covered

Sobeys	23 stores
Metro	85
Super C	6
Maxi	12
Provigo	75
IGA	120
Costco	6
Atlantic Stores	22
Small stores	85
Total	**494**

Our Specialized Products

- Ultra Jumbo
- Ultra Brown
- 2 yolks
- Eggs dated on the day of laying
- Omega-3
- 6 brown, white
- Free run eggs
- Plein d'œuf 18
- Christmas eggs
- Easter eggs
- Le 30 oeufs
- Rigol'oeuf
- Vitamin'oeuf
- Déjeunez à d'œufs
- Nursery eggs

Omega-3, the history

- Developed by University of Guelph
- Linseed in hen's ration
- 10 times more omega-3 as « normal » egg
- February 1995 launching of omega-3 eggs (Frank Born, Vancouver)
- 1996 Bon-e-Best and **Avibro** launch their product (Ontario and **Quebec**)

Consumer Study April 1997

- 100 people per town,
- 18 year-old and above
- Consuming 1 egg/week minimum
- Bought mostly in food chains
- Held over 2 days in 3 towns
- Montreal, Toronto and Vancouver

Study of Purchase Intentions

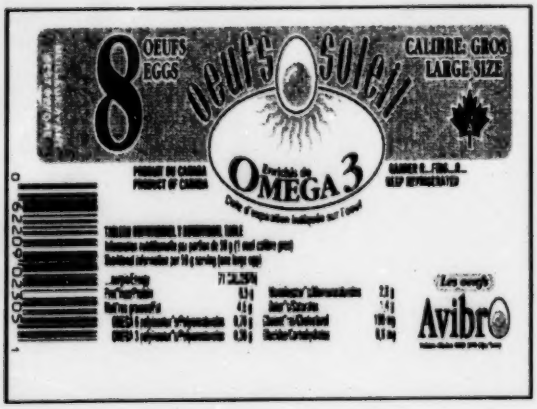
- Question:
- *Have heard about*
- What does omega-3 mean (in your words)

- Answer:
- More nutritious/health **37 %**
- Good cholest./reduce cholest. **12 %**
- An oil/gel **12 %**
- Found in fish **8 %**
- Reduce fat **4 %**
- Don't know **29 %**

Study of Purchase Intentions

- Question:
- Have you **seen** omega-3 eggs in store?
- Have you **bought** omega-3 eggs?

- Answer:
- Yes **55 %**
- No **45 %**
- Yes **45 %**
- No **55 %**



Study of purchase intentions

Question:	Answer:
Information on the package lead you to believe that	Contains less cholest. 43 % More expensive 39 % More nutritious 37 % Keeps longer 12 % Tastes better 12 %

Study of Purchase Intentions

Question:	Answer:
From a health standpoint, what does this mean: «Omega-3 enriched eggs contain more polyunsaturated omega-3 fatty acids »	Less harmful than saturated fat 41 % Good for you 39 % Prevents accum. chol./less 26 % Reduces risks of cardiac problems 9 % Never heard of it 9 % Can eat more 6 %

Study of Purchase Intentions

Question:	Answer:
Is the omega-3 claim credible?	Very credible 27 % Somewhat 57 % Not really 11 % Not at all 5 %

Study of purchase intentions

- Question:
  - Why is the omega-3 claim «not really credible» or «not credible at all» ?
- Answer:
  - No proof **33 %**
  - An egg is an egg /cannot change **27 %**
  - Even if claimed = true **16 %**
  - Animals make fat / product = fat **14 %**
  - Cannot alter nature **14 %**

Study on Purchase Intentions

- Following information received about omega-3 eggs, what are your purchase intentions concerning products that contain omega-3s ?
- **75 %** of respondents say they would be very interested or interested.

Market Share Evolution Omega-3 eggs

- Market share versus total **Avibro eggs**
- 1996 0,50 %
- 1997 0,75 %
- 1998 1,25 %
- 1999 **2,50 %** Promotion by chains

Omega-3 egg / regular egg

Omega-3		Regular	Difference
Cost of production	1.69$/dz	1.52$/dz	0.17$
Chains	2.10$/dz	1.60$/dz	0.50$
Gross margin (producer)	**0.41$/dz**	**0.08$/dz**	**0.33$**
Consumer	2.55$/dz	1.79$/dz	0.76$
Store margin	**0.35$/dz**	**0.19$/dz**	**0.16$**

- **So 2.5 % X 5.12 (gross profit)**
  - ***12,8 %***

Summary

- Introduced in 1995
- Distribution in close to 80 % of stores in Canada
- Represents between 2 and 3.5 % of egg sales in stores
- 5 times more profit than normal product
- Excellent niche product
- Need promotion to reach full potential

Thank you from

Les Œufs Avibro

The truth and consequences of milking management and udder health on Ontario dairy farms

D. F. Kelton, K. E. Leslie, M. A. Godkin, D. Alves and K. D. Lissemore
Ontario Veterinary College, University of Guelph and Ontario Ministry of Agriculture, Food and Rural Affairs

Introduction

The relationship between milking management and udder health is one of the foundation blocks on which contagious mastitis control programs have been built. The decline in the Ontario provincial somatic cell count (SCC) between 1989 and 1994 has been partly attributed to the strong promotion of improved milking management and milking hygiene practices. Unfortunately, there is little real evidence to support this perception. In fact, with the slow increase in the provincial SCC over the last two or three years, the effectiveness of our current milking management practices could be questioned. Recently, two research projects were initiated to better document and categorize the adoption of milking management practices by Ontario dairy producers and to determine the relationships between these practices and measures of udder health and milk quality. The first project was an extensive survey of management practices on almost 3,000 dairy farms, while the second was an intensive study of 60 Sentinel farms.

A survey of milking management practices on 3,000 Ontario dairy farms

In the fall of 1997 a survey of milking management practices on Ontario dairy farms was conducted. Of the 7,600 dairy herds in the province, the survey was administered to 5,300 dairy producers that subscribe to Ontario DHI services. The questionnaire posed questions about general farm characteristics and milking management procedures used on the farm. Specific information was requested about the approach and the products used in pre-milking udder preparation, pre-milking teat disinfection, and post-milking teat disinfection.

A total of 2,946 surveys were completed and returned. Based on their responses, the vast majority of Ontario producers use a traditional approach to pre-milking udder preparation, with 65.2% of producers using a wet wash/dry approach to cow preparation.

Of the herds that used pre-milking teat preparation, 23.5% reported using an iodine sanitizer in their wet wash preparation. The frequency of pre-milking teat disinfection by dipping or spaying was 29.4% (866 of 2,946 herds). This rate of pre-milking teat disinfection in Ontario herds is considerably lower that the 58.3% of herds recently reported in the United States by the National Animal Health Monitoring System (NAHMS). The difference may be due in part to a difference in herd size. The NAHMS report indicated that pre-milking teat disinfection was most common among large herds, with over 70% of herds milking 100 or more cows using a pre-dipping technique.

The adoption of post-milking teat disinfection among the 2,946 respondants was considerably higher. Approximately 94% of herds (2,640) reported using a post-milking teat disinfectant. This is slightly more than the 88. 9% of herds reported by NAHMS. Approximately 50% of the herds using post-milking disinfection were utilizing an iodine-based product. An additional 9.3% of herds did not wish to name their post-milking teat disinfectant. This distribution of iodine use is similar to that reported by NAHMS.

The method of application of pre and post-milking teat disinfectant included both dipping and spraying. Teat-spraying was used by 23.7% and 16.2% of herds for pre-milking and post-milking disinfection, respectively.

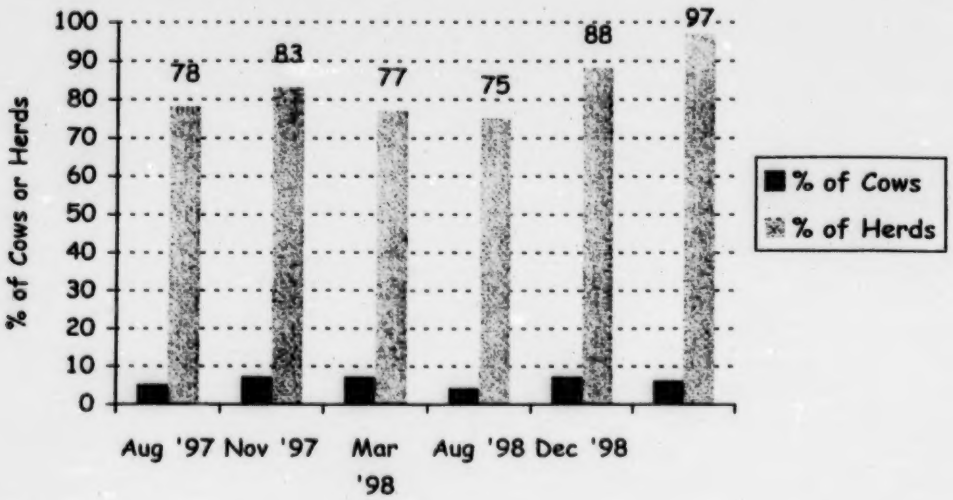
The Sentinel Herd Network

The Sentinel Herd Project was conceived in 1997 to document changes in the prevalence of major mastitis pathogens on Ontario dairy farms, and to evaluate the efficacy of herd and cow management practices in maintaining udder health and milk quality. In May and June of 1997, 40 Ontario dairy practitioners, and 60 of their dairy producer clients, were recruited to participate in the project. Composite milk samples from all lactating cows in each Sentinel herd were collected and cultured during July and August. A milking and management questionnaire was administered to each participating producer at the time of the initial herd culture. Subsequent herd cultures were carried out every four months through December 1998. Composite milk samples from all fresh cows were collected 24 hours after calving. Clinical mastitis cases were recorded and quarter samples were collected and stored. The fresh cow and clinical case samples were stored frozen and cultured periodically.

Milk quality data from the 60 Sentinel herds were compared to all Ontario dairy herds over a 10-year period, January 1988 to September 1997. Based on monthly bulk tank somatic cell count data, these 60 herds had cell counts lower than the provincial average ten years ago. However, they are currently typical of the industry and have maintained an average of about 250,000 cells/ml over the last two years.

Composite milk samples from all lactating cows in each Sentinel herd were collected and cultured during five periods; August 1997; November 1997; March 1998; August 1998; and November 1998. During the five rounds of herd cultures, over 18,000 composite cow samples were plated. *Streptococcus agalactiae* was isolated only sporadically, with a total of 16 positive cows in nine of the Sentinel herds. Overall, based on all five rounds of herd cultures, approximately 6% of samples contained *Staphylococcus aureus*, less than 1% had coliforms and 4% had environmental streptococci. At the herd level, 97% of herds have had at least one cow culture positive for *Staph. aureus* (Figure 1). In total, all 60 herds had at least one sample culture positive for a major environmental mastitis pathogen. While the overall distribution of organisms in this population of cows did not change dramatically, there was considerable variation in the prevalence of *Staph. aureus* cows among the Sentinel herds, from culture to culture.

Figure 1. Percent of cows and herds culture positive for *Staph. aureus* over the first four rounds of herd cultures.



The milking and management questionnaire administered to each participating producer at the time of the initial herd culture included several questions pertaining to the herd's biosecurity practices. Based on the first four rounds of herd cultures, only four herds did not have any cows from which *Staphylococcus aureus* (abbreviated HS) was isolated (negative herds). An additional three and six herds had positive cows on one or two herd cultures, respectively. Fifteen herds were positive three times and 32 herds all four times. As HS has now been shown to be present in most of these herds, it is likely that many herds run a great risk of introducing this infection at some time. Therefore, it is of importance and relevance to examine the factors that appear to control it within a herd, once it is introduced.

Hygiene at milking time is important for reducing the spread of contagious mastitis pathogens such as HS within the herd. To examine the relationship of these practices to HS infection, pre-milking practices were categorized as "acceptable" (wash, dry and pre-dip; wash and dry; or pre-dip and dry) or "unacceptable" (dry wipe; wash only; no prep; or use of "baby wipe" products). Unacceptable and acceptable practices were evaluated for their association with low (0, 1, or 2 herd cultures positive) or high (3 or 4) prevalence of HS. Analysis of this data revealed that herds using "unacceptable" practices were five times more likely to have cows HS positive on three or more repeated herd cultures. This suggests that a relationship between udder preparation and the spread of HS in these herds exists and needs to be examined further.

Post-milking teat disinfection is intended to prevent the colonization of teat skin with HS at milking time. Fifty-seven of 60 herds applied a disinfectant after milking, eight by spraying and 47 by dipping. No comparison to no dipping could be made in this study because there are too few "control" (non-disinfected) herds. Interestingly, both non-disinfecting herds had at least one positive cow at each of the five herd cultures.

Other practices, such as establishing a milking order based on the udder health status of cows in the herd, have been shown to be effective and practical means of reducing the spread of contagious mastitis within the herd. While 12 and 36 responders felt that their herd likely

contained cows infected with *Streptococcus agalactiae* and *Staphylococcus aureus* (before any project culturing was done), only 28 herds reported that mastitis affected the milking order of the herd.

From the information collected, it is clear that HS udder infection is common in Ontario herds. Effective within-herd biosecurity practices are lacking in many herds, and are of poor quality in others. There is a need to focus on these issues in farm level extension programs.

For further information

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About the speaker

Background:

- *Graduated from the University of Guelph with D.V.M. in 1984*
- *Completed internship and residency at Cornell in 1987*
- *Returned to Ontario Veterinary College, University of Guelph in 1987*
- *Completed M. Sc. in Theriogenology in 1989*
- *Completed Ph.D. in Epidemiology in 1995*

Current Status:

- *Assistant Professor in Epidemiology and Health Management in the Department of Population Medicine, Ontario Veterinary College, University of Guelph.*
- *Part-time research and development appointment with the Ontario Dairy Herd Improvement (DHI) and Promark Technologies, with involvement in the implementation of Dairy Comp 305 and the Canadian Milk Recording Project.*
- *Teaching responsibilities include clinical teaching in dairy production medicine and lecturing in applied epidemiology.*
- *Research interests include mastitis and udder health in dairy herds, metabolic diseases of dairy cows, and disease surveillance systems for dairy populations.*

New diagnostic tools for mastitis

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Bovine mastitis is the most frequently encountered illness in the dairy industry, and the most costly. These costs are incurred in treating the sick animals and as a result of the permanent decrease in production. Often, the episode of mastitis cannot be visually detected. The diagnosis is, therefore, of sub-clinical mastitis, and the somatic cell count test is used to try to identify the sick animals. It has been demonstrated that internal udder infections caused by bacteria are primarily responsible for increases in somatic cell counts in milk. In fact, 90% of increases in cell counts are associated with this infection. One of the main bacterial agents responsible for cases of contagious mastitis in North America is *Streptococcus agalactiae* (*S. ag.*). The natural habitat of *S. ag.* is limited to the udder and its transmission from one animal to another occurs during milking. Of great concern is the fact that up to 75% of the animals can be infected in a herd that is *S. ag.* positive. A recent study of 325 dairy herds in Quebec demonstrated that the proportion of herds infected with *S. ag.* was very high (47%). The presence of bacteria in these herds is associated with a significantly higher average of somatic cell counts (SCC). The SCC is a good indicator of milk quality, but is not the best tool to detect infections in individual cows or herds, and does not yield any information concerning the type of bacteria present.

Data on the characteristics of different strains of *S. ag.* isolated in milk is quasi non-existent. There are, for example, different *S. ag.* serotypes. The bacteria is "encapsulated", that is to say, coated by a capsule that can vary according to the bacteria present. Two different *S. ag.* serotypes will have different capsules. In fact, there are more than six different types of capsules. Further complicating the diagnosis, two strains of *S. ag.* can have the same serotype while being genetically different.

It is very difficult to undertake epidemiological studies without the proper tools and relevant information. Moreover, bacterial culture is currently the only technique that allows for the identification of the pathogens causing mastitis. In order to be effective, an *S. ag.* control or eradication program must include early identification of the infected cows and herds, allowing for quick implementation of appropriate measures to limit the transmission of this contagious bacteria.

The probability of isolating *S. ag.* in a bulk tank varies according to the number of cows infected, the amount of bacteria shed by these cows, the dilution effect caused by the production of other cows in the herd, and the sensitivity of the diagnostic method used. Isolation of *S. ag.* in a bulk milk tank is a very reliable indicator of the presence of udder infections in a herd. The culture of milk in a bulk tank is not, however, a very sensitive method. For that reason, a negative result does not guarantee the absence of infection. *S. ag.* is the most significant problem encountered in Canadian dairy herds, even though we know the appropriate ways of fighting this bacteria. We must, therefore, concentrate our efforts on fighting *S. ag.* infections over the coming months and years, in order to meet our objective of reducing somatic cell counts in milk.

In search of a test

In 1996, the Dairy Farmers of Canada provided us with financial support to undertake the development of a test that would allow the detection of *S. ag.* in milk. The project had the following objectives: 1) To establish a system for identifying the serotype of bovine strains of

S. ag. (serotyping: identifying the type of capsule present) and to study the distribution of the different serotypes in the strains found in Quebec. It is important to note that such a system was only available, before this project, to study strains of human origin; 2) To establish a sub-typing system allowing the study of strains belonging to the same serotype and of strains that cannot be typed (*S ag.* strains in an unknown capsule). In other words: Are two strains of the same serotype genetically identical? Is the *S. ag.* strain present in my herd the same as that in my neighbour's herd?; 3) To develop a sensitive and specific test allowing direct detection of *S. ag.* in milk.

What have we accomplished to date?

First objective: A total of 295 strains of *S. ag.* from eight different regions of Quebec were serotyped through the agar gel double diffusion test. Results are shown in table 1.

Table 1. Distribution of the different serotypes of *S. ag.* isolated from milk in Quebec.

Origin	Serotype			
	I a/c	II	III	CBT
Alma	1/15	0/15	3/15	11/15
Assomption	2/45	1/45	17 /45	25/45
FVM*	0/19	0/19	1/19	18/19
Nicolet	1/44	5/44	18/44	20/44
Rimouski	0/21	4/21	6/21	11/21
Rock Forest	0/27	3/27	8/27	16/27
Saint-Hyacinthe	1/51	4/51	12/51	34/51
Sainte-Foy	4/73	5/73	17/73	47/93
TOTAL	9/295	22/295	82/295	182/295
Total (%)	3	7. 5	28	62

*Faculty of Veterinary Medicine
CBT: cannot be typed

Of the 295 strains tested, 3% belonged to serotype 1 a/c, 7.5% to serotype II and 28% to serotype III. No strains belonging to serotypes IV, V or VI were found. The percentage of strains that cannot be typed is high (62%). It is not possible, with serotyping, to study the variations that could exist between the strains that cannot be typed.

Second objective: Given the high number of strains that cannot be typed, it was difficult to draw conclusions concerning the distribution of different strains. The nucleic acid subtyping methods are very useful in epidemiological studies. We used one of them, the RAPD (random amplified polymorphic DNA) technique, to do molecular typing (identification of clones or clonal groups) with high discrimination and reproduction capabilities. Results show that there are numerous differences between *S. ag.* strains, even within the same serotype. There was no obvious correlation between geographical regions and strain sub-typing.

Third objective: We standardised a molecular method (PCR) that allowed to directly detect *S. ag.* in milk. This method produced quick results (less than 24 hours), was very sensitive (capable of detecting less than 100 bacteria/ml milk) and specific. We identified no non-specific

reactions from other bacteria that could be present in milk samples, such as *Escherichia coli*, *Streptococcus uberis*, *S. dysgalactiae*, *S. bovis*, enterococci and *Staphylococcus aureus*.

Conclusions

1) Results show that a high proportion of Canadian strains of *S. ag.* do not belong to any of the known serotypes. It is possible that some of these strains cannot be typed or that new types are present. Among the strains that can be typed, serotype III (the most pathogenic in humans) was the one most frequently found.

2) Variability between the Canadian strains of *S. ag.* is very high. Some strains belonging to the same serotype also seem to be different. The molecular tools standardised in this project will allow to conduct more in-depth epidemiological studies.

3) We now have a quick and specific method for detecting *S. ag.* in milk. The diagnosis can be made with very contaminated milk samples and/or milk samples that were not well stored (bacterial mortality). The methods developed in this study will allow us to considerably improve the diagnosis of bovine mastitis and target treatments to control or even eradicate *S. ag.*

Follow-ups and technology transfer of the project

At this time, the Diagnostic Department of the Faculty of Veterinary Medicine of the University of Montreal offers an epidemiological follow-up service in order to determine if two strains obtained from two different sources are, in fact, the same strain. The same Diagnostic Department will soon offer a direct detection service for *S. ag.* in milk, using the PCR technique developed during this project. Private laboratories have shown a keen interest in collaborating to validate this test in order to transfer it to the industry.

We are planning to develop a PCR test allowing to directly detect *Staphylococcus aureus* in milk samples. This test could be incorporated into the method developed for *S. ag.*, which would allow us to detect both bacteria at the same time.

About the speaker

Dr. Gottschalk obtained his D.V.M. in 1982 from the University of Buenos Aires, in Argentina. He then received his Ph.D. in Microbiology and Immunology (1991) at the University of Montreal. He is now full professor at the Faculty of Veterinary Medicine (FVM) of the University of Montreal.

Responsible of the Streptococcus research laboratory, FVM, University of Montreal. The Streptococcus suis laboratory is considered as an international reference laboratory on the serotyping of this micro-organism. Current studies include diagnostic, virulence factors and production of vaccines.

Responsible for the swine pleuropneumoniae serologic diagnostic laboratory, FVM, University of Montreal. This lab is also considered as a reference in North America. Four kits have already been transferred to the industry and have reached the European market.

Why and how mastitis resists treatment: can liposomes be a solution?

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In the United States, economic losses caused by bovine mastitis reach almost U. S. $2 billion. These losses are largely due to the fact that bovine mastitis causes a decrease in both the quantity and the quality of the milk produced. The principal causes of bovine mastitis are *Staphylococcus aureus, Streptococcus uberis, Streptococcus parauberis, Streptococcus agalactiae, Streptococcus dysgalactiae* and *Escherichia coli.* Even though it is recognized that the bacteria that cause bovine mastitis are generally antibiotic-sensitive, antibiotics cannot eliminate the infection in 50% of the cases.

The first objective of this project was to identify and evaluate the importance of the factors responsible for the different bacteria's resistance to antibiotics. We then had to evaluate the ability of Fluidosomes™ (a type of fluid liposome) to increase the effectiveness of antibiotics. Liposomes are small vesicles made up of complex lipids that can contain water or fat-soluble substances. Previous results have demonstrated that Fluidosomes™ dramatically increase the effectiveness of antibiotics against highly resistant bacterial strains.

In the beginning, our work was based on the following hypotheses: 1) bacterial resistance to antibiotics was due to the secretion of a mucous substance called «mucous exopolysaccharides" (MEP) which protects the bacteria from the host's natural immune system (macrophages, antibodies, etc.) and from penetration by the antibiotics; 2) bacteria could be hidden in cells (alveolar and/or white blood cells) shed by the cow suffering from mastitis into the infected milk, which would protect the bacteria against antibiotics and the host's natural defenses.

A number of techniques were developed and/or tested in order to study the importance of the MEP phenomena. These techniques were used to identify and quantify the presence of MEP in infected milk produced by cows suffering from mastitis. Even though this study has not been completed, results obtained to date strongly suggest that the bacteria that cause treatment resistant cases of bovine mastitis generally secrete MEP. The second important element of our study was to demonstrate, for the first time, the presence of bacteria hidden in cells shed by infected cows. This was done using cells isolated from samples of naturally infected milk taken from cows suffering from mastitis. The use of advanced and stringent techniques allowed us to confirm the presence of bacterial DNA in more than one type of cell.

We, therefore, confirmed that bacteria can resist antibiotic treatment and the cow's natural defenses by hiding in its cells.

The fact that we better understand the causes of bacterial resistance to antibiotics during an episode of mastitis should allow us to develop more effective treatments. One possible way could be to use antibiotics or MEP inhibitors encapsulated in liposomes. The benefits of this method were demonstrated in previous *in vivo* experiments that showed that Fluidosomes™ were able to penetrate the MEP and fuse with the bacterial membrane, thereby increasing the degree of penetration of the antibiotic into the bacteria and its subsequent effectiveness. Fluidosomes™ can also be absorbed by the macrophages, thereby delivering the antibiotic to the bacteria that could be hidden within.

In conclusion, the results of this study strongly suggest that the bacteria that cause cases of bovine mastitis that resist conventional antibiotic therapy, may develop highly effective protective mechanisms, both against the host's immune system and against antibiotics. We still need to pinpoint the frequency of the presence of bacteria in the different types of cells found in the milk. It will also be necessary to evaluate the importance of the relationship between intracellular infections and mucosity, and to test the effectiveness of Fluidosomes™ against these different defense systems, whether or not they are present at the same time.

About the speaker

Dr. Lagacé holds a Ph.D. in Virology from Institut Armand-Frappier (1983). She has completed postdoctorate studies in Immunology at the Lady Davis Institute of the Jewish General Hospital in Montreal, with Dr. Mark Wainberg (1983-1984) and at the Laboratory for Infectious Disease Control of Health and Welfare Canada with Dr. Bernard Brodeur (1984-1986). She has been full professor at the Department of Microbiology and Immunology at the University of Montreal since 1986. Since 1987, she has received over $1. 7 million in research funding.

Dr. Lagacé is founder and Vice-President of research and development, of Theralipids inc. and President of the Consulting Commission of the Canadian Technology Network.

Novel protein and gene therapy for the treatment of mastitis

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Introduction

Despite all the progress made in dairy management and antimicrobial therapy, the prevention and treatment of mastitis remain an enormous problem which costs over 200 millions $ per year to the Canadian dairy industry. Accordingly, it has been reported that the proportion of cows reformed for mastitis has increased from 8.2% to 14.5% between 1987 and 1998 in Canada. Even though there are numerous pathogens involved with mastitis, *Staphylococcus aureus* has become, since the early 1980s, the most prevalent mammary pathogens, being present in over 90% of dairy herds.

Antibiotics and antibiotic-resistant bacteria

The widespread utilisation of antibiotics to treat mastitis has led to the increased environmental presence of pathogens less susceptible to their bacteriocidal effect. This has resulted in infections that are more difficult to cure. Nowadays, the efficacy of conventional antibiotic treatments against *S. aureus* is very low. Indeed, recent data shows that the cure rate of cows infected with this bacteria is 49% when antibiotics are used and 43% when no antibiotics are used (Wilson *et al.*, 1998). Moreover, penicillin and closely related antibiotics of the β-lactam family are the best weapons against staphylococci. However, the massive use of these antibiotics has led to a dramatic increase in pathogens that can produce an enzyme called β-lactamase that inactivates β-lactam antibiotics which results in microbial resistance. In some European countries, over 60% of the *S. aureus* that are isolated from bovine mastitis can produce this enzyme (Guérin-Faublée and Brun, 1999).

A new approach using bovine lactoferrin and lactoferricin

Most of our research effort has been directed toward finding alternative approaches to fight *S. aureus* mastitis. In order to cause mastitis, a pathogen must first survive a first line of non-specific host defence mechanism. Lactoferrin (Lf) is an important component of this first line of defence. This protein is naturally produced by the mammary cells of a lactating gland. It is the main whey protein in human milk (1-6 g/L) and it is also present in cow's milk but at a much lower concentration (0.01-0.1 g/L). This protein appears to have many biological functions, including antibacterial and anti-inflammatory activities. The best known effect of Lf is to bind iron which is essential for bacterial growth (Nuijens *et al.*, 1996). This results in low iron availability and therefore inhibits the growth of bacteria in milk. Originally, the antimicrobial activity of Lf was attributed entirely to its iron-sequestering capabilities. However, a fragment of Lf, which cannot bind iron, was found to have a more potent bactericidal effect (10-100 times) than Lf itself (Bellamy *et al.*, 1992). This peptide, named lactoferricin (Lfcin), is naturally produced in the gut of mammals during digestion of milk Lf.

We have investigated *in vitro* the potential of Lf and Lfcin, alone or in combination with antibiotics, to fight mammary pathogens such as *Staphylococcus aureus, Escherichia coli* and *Klebsiella pneumoniae*. Lactoferrin has a weak antibacterial effect when used alone but Lfcin is at least 100 times more potent than Lf to inhibit bacterial growth. This effect appears to be independent of its iron sequestration capability as addition of iron in bacterial growth medium did not influence the growth inhibitory effect of Lf and Lfcin. Interestingly, both Lf and Lfcin appear to be much more effective when used at low concentration in combination with several

antibiotics. They increase by several folds the inhibitory activity of antibiotics such as penicillin, ampicillin, novobiocin, erythromycin and neomycin. The most striking observation is that Lf increases the inhibitory activity of penicillin by four folds or less in most penicillin-susceptible *S. aureus* strains, whereas this increase was 4 to 16 folds in penicillin-resistant strains. Furthermore, we have discovered that Lf and Lfcin dramatically reduce both basal and penicillin-induced β-lactamase activity. Indeed, a low concentration of Lf can reduce by 25 folds the β-lactamase activity of *S. aureus* incubated with penicillin. This is a very important observation as it suggests that Lf can restore susceptibility of bacteria to penicillin. A patent application has been filed (Diarra, Petitclerc and Lacasse) and we will very soon start investigating *in vivo* the efficacy of Lf and Lfcin to cure mastitis. This research is funded through a research partnership between Dairy Farmers of Canada, La Fédération des producteurs de lait du Québec, and Agriculture and Agri-Food Canada.

Development of a vaccine against *S. aureus*

The idea of developing a *S. aureus* vaccine is very appealing and several attempts have been made in the past. Unfortunately, classic vaccination techniques have been largely ineffective, probably because they induced an inappropriate immune response in the cow. However, recent advances in vaccination technology and a better understanding of the bovine immune system may render the development of a vaccine against *S. aureus* possible.

Basic knowledge from DNA technology, genetic engineering and biotechnology has led to the development of DNA immunization techniques. The basic framework of a DNA vaccine is a circular fragment of genetic material called a plasmid that contains the genetic code (DNA) of a specific protein or peptide (an antigen) from a bacteria or a virus. When the plasmid is injected into an animal, it enters the cells and the antigen is produced. The antigen induces in the animal a cascade of immune events establishing protection against the pathogen. This technology has been used successfully to develop a vaccine against bovine viral diarrhea (Harpin *et al.* 1999). An important advantage of this type of vaccine is the flexibility to manipulate the immune response in order to reach an effective protection. Also of importance, DNA sequences are cheap to produce and very stable.

When *S. aureus* infects a mammary gland, it will adhere to the cells of the mammary gland and then, secrete a viscous substance while invading mammary tissues. Once *S. aureus* has colonised the gland, it is very difficult for the immune system to eliminate it. Therefore, we have chosen to target the first step of colonisation, adhesion, to prevent infection. We have selected genes expressing proteins which are essential for bacterial adhesion. These genes have been isolated and we will start soon to immunize small laboratory animals to validate this approach. This research is funded through a partnership of Novalait inc., the Quebec Ministry of Agriculture, Fisheries, and Food, Le Fonds FCAR, Sherbrooke University, and Agriculture and Agri-Food Canada.

Gene therapy

DNA technology through gene therapy could also be used to fight mastitis directly into the mammary gland of lactating animals. Indeed, the production of a foreign protein in milk was shown over a period of 60 days after injecting a DNA plasmid into the mammary gland of lactating ewes (Gagné *et al.* 1997). This technology opened the exciting possibility of using DNA technology/gene therapy to release proteins or peptides with bacteriocidal activity into milk to cure and/or prevent mammary infections. Hence, proteins and peptides such as Lf and Lfcin,

whose concentrations are naturally low or virtually absent in cow's milk, could be secreted in milk at higher concentrations using gene therapy to prevent and/or cure mastitis.

The mammary gland could also be induced by DNA technology and gene therapy to produce other compounds that will help to prevent or cure mastitis. For example, lysostaphin was found very effective in treating *S. aureus* mastitis in cows after intramammary injection (Oldham and Daley, 1991). Lysostaphin is an enzyme only produced by *Staphyloccus simulan* which will rupture specifically the cell wall of other staphylocci bacteria.

Much research is needed to demonstrate the feasibility, efficacy and acceptance of gene therapy to fight mastitis in farm animals.

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About the speaker

Dr. Petitclerc obtained his Ph.D. in Physiology from Michigan State University in 1983. The title of his thesis is "Photoperiod, a signal for stimulation of prolactin secretion and body growth in cattle."

His research interests now include mammary gland development, with a long term objective to improve its permanent milk production capacity; milk composition, to improve the nutritive and functional properties of milk by mastering the synthesis of components; and finally the health of the mammary gland. This last part of his work aims at reducing the economic losses associated with mastitis as well as reducing the use of antibiotics.

Antimicrobial resistance: current perspectives

Rebecca Irwin
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Increasingly, the issue of antimicrobial resistance has become a topic of conversation for both legislators and the public alike. Television, radio and print media have dedicated large segments to the issue of emerging antimicrobial resistance in human pathogens. Major problems have arisen in hospital environments where antibiotics are widely used. Bacterial infections associated with methicillin-resistant *Staphylococcus aureus* (MRSA), and vancomycin-resistant Enterococcus (VRE) are becoming more and more commonplace. In the community, infections with multi-resistant tuberculosis and penicillin-resistant *Streptococcus pneumoniae* are also emerging. Human illnesses associated with multi-resistant foodborne pathogens such as *Salmonella typhimurium* DT 104, *Campylobacter* and *E. coli* are also recognized. The rising antimicrobial resistance in human pathogens has focussed the attention on both the medical and agricultural uses of antimicrobials.

Antibiotics are vital medicines for the treatment of bacterial infections in both humans and animals. Antibiotics have also proved to be important for sustainable livestock production and for the control of animal infections that could be passed on to humans. Certain antimicrobials used for treatment or growth promotion in agriculture are also used for disease control in humans. Others select for cross-resistance in bacteria to antimicrobials used in human medicine. This means that a bacteria resistant to a growth promoter may become resistant to another antimicrobial used in human medicine. Microbiological and clinical evidence is mounting that resistant bacteria or resistance determinants – the molecular, or genetic packages of information which provide the bacteria with the ability to become resistant to antibiotics, can be passed from animals to humans. This can occur via direct contact with animals or consumption of food, resulting in infections that are more difficult to treat.

Antibiotics are used extensively in livestock, fish and plant production. Some countries report that more than 50 percent of their total output of antimicrobial compounds is used in agriculture. Most are applied to food animals in subtherapeutic doses as growth promoters, which boost the utilisation of the genetic potential for growth. The use of antimicrobial agents as growth promoters continues to generate criticism that they are used for purely economic reasons and as substitutes for good husbandry and hygiene. Many countries have instituted policies to restrict the use of antibiotics useful in human therapeutics from use in growth promotion.

Internationally, public health and regulatory authorities are reviewing potential strategies to control the emergence and reduce the spread of antibiotic resistant organisms. The World Health Organization (WHO) has convened two meetings recently to develop recommendations on the use of antimicrobials in food production. The WHO is supporting the development of guidelines which promote the "usage of antimicrobials which maximizes therapeutic effects and minimizes the development of antimicrobial resistance". The WHO has further recommended that the use of any antimicrobial agent for growth promotion in animals should be terminated if it is: used in human therapeutics; or known to select for cross-resistance to antimicrobials used in human medicine.

There is an extreme range in government policies to control the use of antimicrobials in agriculture. For example, at one end of the spectrum is Sweden, where all antimicrobial growth promoters (AGP) have been banned for use in feed. At the other end of the spectrum are

countries where antimicrobials are freely available without prescription for use in both humans and animals.

In response to growing pressure from Sweden, Denmark, and Finland, the European Union recently banned the growth promotants tylosin, spiramycin, virginiamycin and bacitracin for use in animal feeds. This ban, which took effect July 1, 1999, is expected to have a major impact on the international trade of animal products.

The U.S. has introduced several measures to respond to the growing concern over antimicrobial resistance. They banned the extra-label use of glycopeptides and fluoroquinolones; they developed a national antimicrobial resistance monitoring system (NARMS) to capture data on enteric organisms from humans, animals and food; and more recently they have introduced a draft framework for the approval of new antimicrobial drugs. This framework will require pharmaceutical manufacturers to provide pre-approval and post-approval monitoring data to enable regulators to evaluate the potential risk to human health.

Canada is also concerned about the emergence of antimicrobial resistance in human pathogens. Health Canada convened a consensus conference in May, 1997 to develop recommendations to tackle this issue. In response to one of the recommendations from this conference, the Canadian Coordinating Committee on Antimicrobial Resistance (CCCAR) was formed. The mandate of this Committee is to promote the development and implementation of strategies to focus efforts of health-care providers, industry and Canadian consumers toward the goal of more effective use of antibiotics and to limit the development and transmission of antimicrobial resistant bacteria.

Health Canada's Food Directorate is taking a lead role in the development of strategies to control the emergence and spread of antimicrobial resistance from agriculture and food sources. In June of last year, Health Canada sponsored a stakeholder consultation workshop to provide a forum for discussion of topics related to prudent use, surveillance and research. As a next step, Health Canada will be forming a National Steering Committee made up of representatives from government (federal/provincial), industry, public health, consumers, diagnostic laboratories and academia.

The development of policies to control the emergence of antimicrobial resistance is a complex task. Multiple issues will need to be addressed. There is a critical need to provide the scientific information which characterizes the link between antimicrobial use in animals and resistance in humans and to answer questions on how resistance may be transferred to humans via food or environmental exposures.

About the speaker

Dr. Irwin received her Doctor of Veterinary Medicine degree in 1986, and a Master of Science degree in Epidemiology in 1988 from the Ontario Veterinary College of the University of Guelph, where her research was focussed on poultry-associated food borne pathogens. She worked for Agriculture and Agri-Food Canada from 1986 to 1996 where she collaborated on many food safety assignments within both the Meat Hygiene and Animal Health Divisions. Dr. Irwin joined Health Canada in 1996 where she works within the Food Directorate of the Health Protection Branch. She continues to provide scientific support on food safety issues, but her main focus of activity is related to her new position as the Food Programme Coordinator for Antimicrobial Resistance.

Antibiotic policy in Norwegian and Swedish dairy production–The "Nordic Approach"

By Kerstin Plym Forshell[1], Olav Østerås[1], Sven-Ove Olsson[2], Torkel Ekman[2], and Charlotte Hallén Sandgren[2]

1) The Norwegian Cattle Health Services/ TINE Norwegian Dairies BA
2) The Swedish Dairy Association

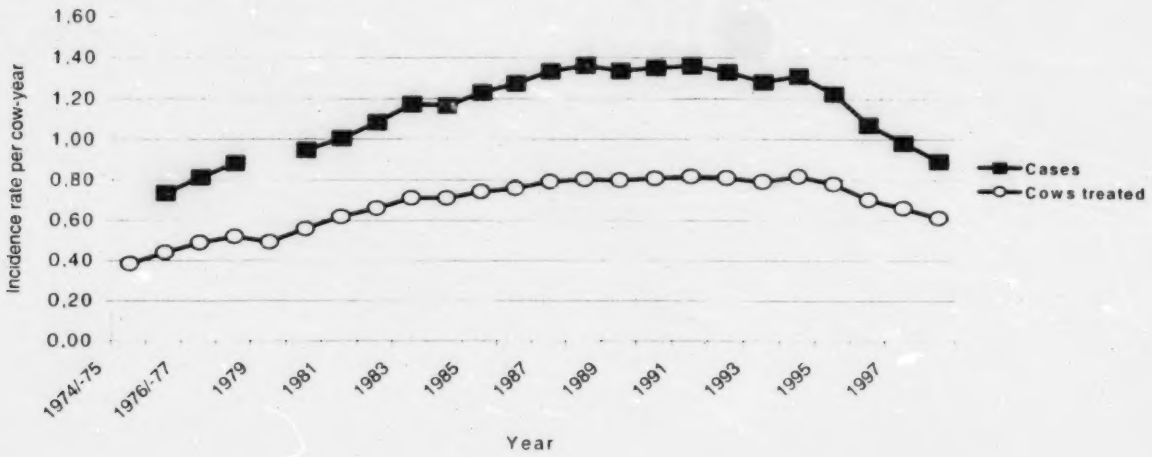
Abstract

The antibiotic policy in Norway and Sweden is presented as a Nordic example of successful actions taken to reduce the use of antibiotics in dairy production. Both countries have banned the use of antibiotics in feed as growth promoters. In Norway, treatments of mastitis have decreased by 30% since 1995 and are still decreasing. In Sweden, the incidence rate has been quite low during the same period. The therapeutic regimens and quality payment systems are different in the two countries. This probably explains at least partly the differences in bulk tank somatic cell counts (BTSCC) and the level of treatments. The progress made is dependent on well functioning disease recording systems, restricted use of antibiotics separated from sale and comprehensive programs for cattle health services as well as effective breeding programmes. The changed attitude among farmers, consultants and veterinarians about the use of antibiotics in milk production was explained by a greater focus on preventive health care, increased extension work and increased educational level among the farmers.

The Norwegian disease recording system

After a test period that started in 1971, a full-scale recording system for diseases in dairy production (the health card system) was introduced in the whole country in 1975/1976. The cow health card system was a joint venture between the Norwegian Breeding Association (Geno) and the Norwegian Veterinary Association. This system is incorporated in 1995 as the basic part of the Norwegian Cattle Health Services, which is a joint venture between the National Veterinary Authorities, the dairy producers, meat producers, breeding associations and the veterinary association. The veterinarians and dairy producers record information on the health card about any cattle (beef and dairy) that is treated for a disease. These records are periodically sent to a central database in Oslo, combined with other production and milk quality data from the same herd. Each second month a rolling twelve-month report with specific statistics on health-related data is sent back to all dairy farmers. The farmers also get an annual report. Regional statistics are also available for veterinarians and advisors four times a year. This compulsory disease recording system is run by TINE Norwegian Dairies BA, and supervised by the board of the Norwegian Cattle Health Services. A copy base with data from 1989 onward was made available for research purposes in 1998. The recorded disease incidence over time can easily be followed with this system and is presented in Figure 1.

Figure 1. Recorded disease incidence in Norwegian dairy cattle 1975 –1998 (2).



The Swedish disease recording system

The Swedish disease recording system, which is also compulsory, was introduced in 1982 by the Swedish Dairy Association (foremerly the Swedish Association for Livestock, Breeding and Production (SHS)), together with the National Board of Agriculture. Until 1999, the system consisted of standardized data sheets for the veterinarian to use at every treatment made on a production animal at a farm. The data were registered by the local livestock association and sent to the main frame at the Swedish Dairy Association. The data were then used together with production data in the milk recording system. Farmers received monthly and annual reports. Since 1999, the National Board of Agriculture is responsible for the database. The government-employed farm animal veterinarians (district veterinarians) are now using personal computers for registration of data and direct transfer to the main frame. Disease diagnosed, as well as treatment method and amount of antibiotics per animal is recorded, making it possible to follow each millilitre of antibiotics used at the individual and farm level. Disease data are transferred weekly to the database for milk recording administered by the Swedish Dairy Association, still making it possible to use the data in herds affiliated to the milk recording services. The private large animal practitioners use a paper-based registration system. The data are stored for a minimum of three and five years for health and AI data, respectively. Data used for research purposes can be stored for longer periods in other systems (1).

Preventive veterinary medicine/herd health programmes

Cattle health programmes have been used in the two countries as preventive veterinary services offered to the farmers since 1970-1975. During the first period of ten to fifteen years, the efforts were concentrated on mastitis and reproduction problems. The farmers were offered regular visits with clinical examinations, CMT-testing (California Mastitis Test), milk sampling for bacteriological diagnosis, mastitis therapy and advise to avoid further problems. In both countries, veterinarians were responsible for the service, even though technicians also were involved, mainly to check milking technique and test milking equipment. Over the last ten to fifteen years, the service principles have been further developed, now including other diseases and general herd health investigations.

Drugs are used upon prescription from veterinarians who are not allowed to sells drugs for profit. Neither technicians nor farmers are allowed to use any antibiotic drugs without a veterinary diagnosis and prescription. The herd health programmes in the two countries are now in a phase of adjustments as a consequence of improved cattle health status and increased demands from consumers and the dairy industry for further reduction of antibiotic use and increased focus on prevention of cattle diseases.

Mastitis therapy

During the time period described, the discussions about relevant mastitis therapy have been very active and intense in the veterinary societies in the two countries. Test trials for different antibiotic drugs have been made in the two countries as well as other investigations on the same subject. The mastitis bacteriological panorama and microbe resistance pattern is not very different between the two countries (Table 1).

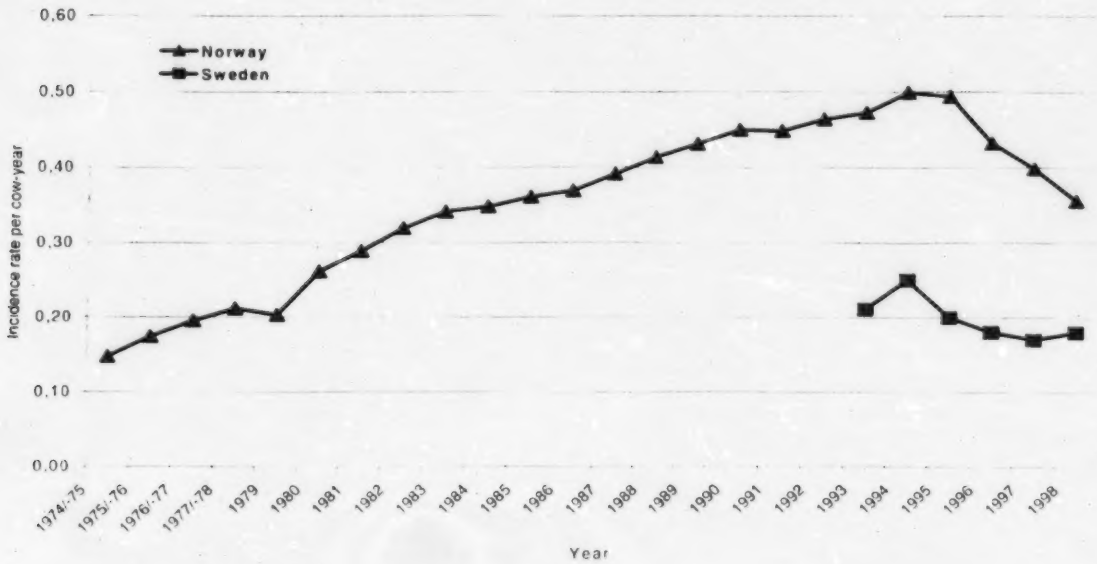
Table 1. Proportional rate of the most predominant mastitis pathogens isolated from clinical and subclinical mastitis in Norway and Sweden in 1998 (percent of strains recorded as penicillin-G resistance in brackets).

Bacteria	Norway				Sweden			
	Clinical mastitis		Subclinical mastitis		Clinical mastitis (2)		Subclinical mastitis (3)	
Staph. aureus	43. 7	(6. 0)	57. 3	(17. 5)	25. 1	(6. 1)	33	(17)
Strep. dysgalactiae	13. 1	(0. 6)	12. 7	(0. 5)	15. 7		11	
Escherichia coli	12. 3	(100. 0)	1. 3	(100. 0)	18. 6		5. 5	
CNS[a]	4. 9	(28. 3)	22. 7	(30. 0)	4. 9	(25. 7)	33	(33)
Strep. agalactiae	0. 2	(0. 0)	0. 3	(0. 0)	0. 6		<1	

a. Coagulase negative Staphylococci

Even if the general conditions are fairly similar, the principles related to mastitis therapy show some important differences. The mastitis incidence in the two countries is illustrated in a figure presented by a Nordic Dairy Group (Figure 2).

Figure 2. Rate of clinical mastitis incidence in Norway and Sweden (2).



In Norway, the farmers commonly use CMT at the farm to check the inflammatory status and then judge if a call for veterinary-assisted treatment is needed. In Sweden, as a main rule, technicians or veterinarians use the CMT as a complement to cow milk somatic cell count.

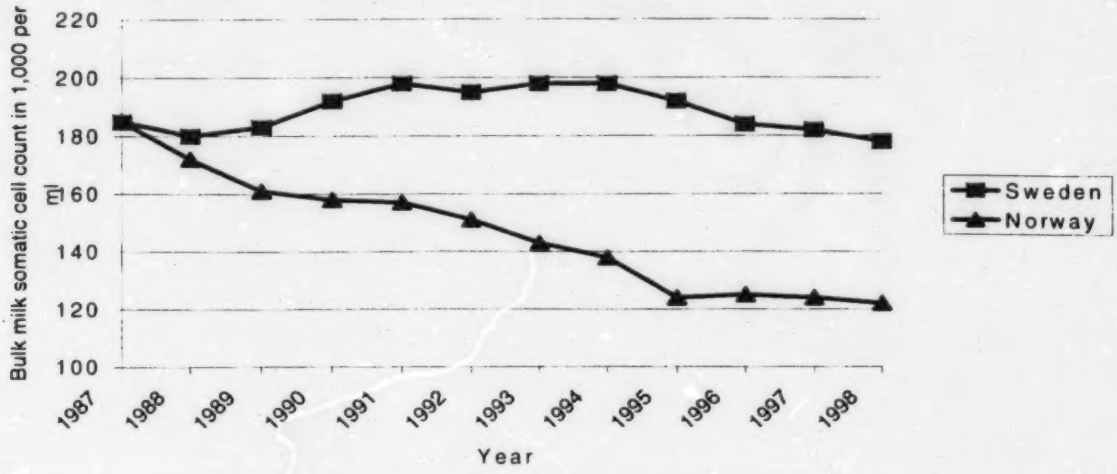
The Norwegian veterinarian initiates the treatment with an intramuscular injection of penicillin-G, which is the "drug of choice" in both countries. The farmer completes the treatment with intra mammary tubes for three to four days. No specific dry cow treatment drugs are available. The Swedish veterinarian also initiates the treatment with an intramuscular injection, but the farmer continues with intramuscular injections for another three to four days (4). Selective dry cow therapy is commonly used. General dry cow therapy is very seldom used in the two countries.

Veterinarians in Norway regularly sample the cows for laboratory bacteriological analysis. Swedish veterinarians regularly sample the cows to make bacteriological analysis on their own in order to change the therapy if the infection is caused by Gram-negative bacteria.

The Norwegian withholding times are in general shorter than in Sweden. Teat dipping is more frequently used in Sweden than in Norway, and is only used after milking, in accordance with EU regulations.

The maximum accepted bulk tank somatic cell count (BTSCC) is 400,000 cells per ml in Norway, counted as a geometric mean over a three months period. There are economic penalties at 300,000 and 350,000 per ml. BTSCC levels below 230,000 cells/ml give a premium of + 0. 14 NOK per litre of milk delivered. In Sweden, the same maximum level is used, and most of the dairies offer small economic incentives for low BTSCC levels and quite large penalties for high cell counts. The level of BTSCC in Norway and Sweden is illustrated in Figure 3.

Figure 3. Bulk tank somatic cell counts (BTSCC) in Norway and Sweden 1987-1998 (5)



National regulations on the use of antimicrobials

The use of antibiotic drugs in veterinary medicine is strictly regulated in the two countries. According to Swedish law, antibiotics and chemotherapeuticals may only be incorporated in animal feed for the purpose of preventing, alleviating or curing disease, i. e. not for growth or yield promoting purposes. In Norway, the farmers associations have established self regulation forbidding the use of antibiotics as feed additives.

In Sweden, approval of antibacterials as well as withdrawal times in animals are authorised by the National Medical Products Agency. All antibacterials, hormones and other formulations for use in animals are available upon veterinary prescription only. The general veterinary regulations of the Board of Agriculture state that "the usage of medicinal products shall be motivated. When choosing type and dosage of a medicinal product, the risk of residues in food of animal origin shall be taken into account". They also state that "prescribing and handing out medicinal products shall be done with great restrictivity and only when the need is apparent". According to the same regulations, medicinal products may, in each occasion, be prescribed or handed out only after careful examination of the diseased animal or herd (6). This has resulted in a general awareness about the importance of minimal use of antibiotics in the pig and poultry industries as well as in dairy production. It also supports the general attitude toward reducing the use of antibiotics as much as possible in any kind of food production.

In Norway, the corresponding regulations are formulated by the National Drug Regulatory Authorities with the same attitude as in Sweden. The policy on use of antibiotics has been strengthened since 1995 by both the Norwegian Cattle Health Services (7) and the National Drug Regulation Authorities. Specific guidelines were set up on how to use antibiotics and how to act in case of no cure response and occurrence of resistance problems (8). Pressure is made to perform correct preventive measures, and thus there should be very little need for new types of antibiotic formulas. In fact, penicillin G still is the drug of choice.

Antibiotic policy in dairy production

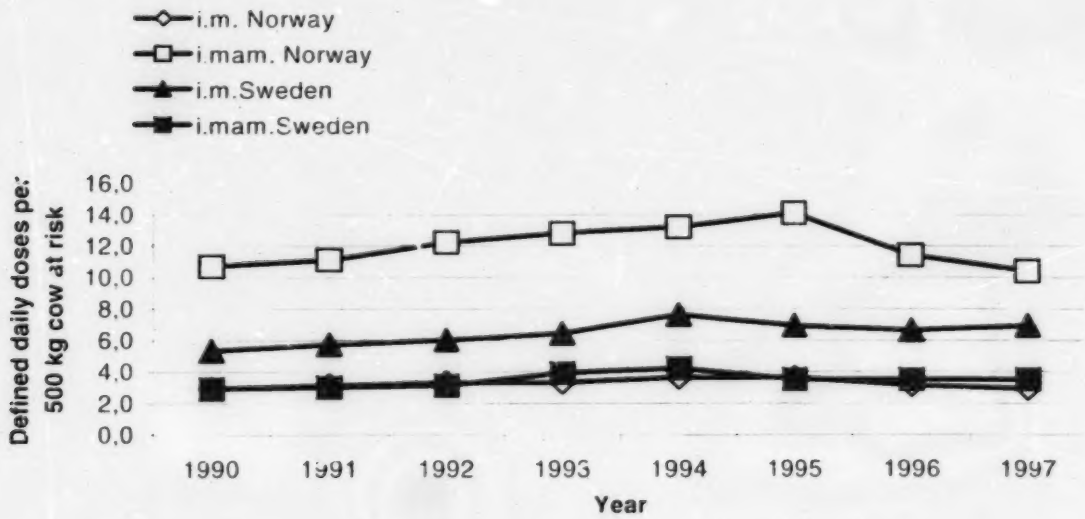
During the last decade, there has been a general growing concern in the two countries about the risks of increasing resistance of the microbial strains in animal production associated with the use of antibiotics.

Thus, in Norway, a strategy was formulated in 1996 to reduce the use of antibiotics in animal production by 25% in five years, i. e. by 2001 (9). In order to reach this goal, the Animal Health Services for cattle, pigs, sheep/goat and poultry organized the following actions:

1. Increased actions by the political and business organizations of farmers as well as by veterinary organizations to reinforce preventive veterinary medicine and health programs.
2. Focus on the use of antibiotics in food producing animals in the Quality Assurance System ("KSL").
3. General concern about antimicrobial resistance in the breeding programs.
4. General support from the different organizations as to relevant research and development projects in the area of interest.
5. Introduction of action plans for the different species in order to reach the goal.

The results of these actions could be registered almost directly, and the goal was reached after three years only. This was confirmed by a 28% decrease in the incidence rate of treated cases of mastitis and a corresponding reduction of antibiotics prescribed at the pharmacies. Figure 4 illustrates these results.

Figure 4. Defined daily doses of antimicrobial drugs as intramuscular (i. m.) and intramammaries (i. mam.) injections.



During the winter of 1998/1999, a questionnaire was sent out to 2400 producers, advisors and veterinarians in order to identify the reasons why the antibiotic reduction campaign had been so successful. The response rate for this questionnaire was 65. 9%. The changed attitude among farmers, consultants and veterinarians about the use of antibiotics in milk production was explained by a greater focus on preventive health care, increased extension work and increased educational level among the farmers. The study (11) also revealed that most of the participants believed in the possibility of further reducing the use of antibiotics. As an example, a new

reduction goal of 5% for mastitis incidence per year over five years was put in place by the Norwegian Cattle Health Services.

In Sweden, a corresponding process of reduction was initiated in the mid-nineties. Prolonged withholding times for procaine penicillin-G and the implementation of the EU regulations, together with demands for high-quality milk had increased incidence of mastitis treatments. The Dairy Cattle Health Services in the Swedish Dairy Association initiated an intense information campaign about the proper use of antibiotics, including the "drug of choice", in mastitis therapy (12). Mastitis therapy was chosen as the "main area of interest" as most of the antibiotics prescribed to dairy cattle were used for this purpose. The campaign was successful. Incidence rate of treatment of mastitis decreased from 23. 6% to 18. 3% and use of antibiotics was reduced. Since 1997/98 there has, however, been an increase in the use of procainpenicillins, probably largely due to an increased use of systemic treatment at drying off and a slight increase in the doses used in the field. The treatment incidence of mastitis, largely clinical mastitis, has not increased. The board of farmers in the dairy industry now has decided to set a new goal of 25% reduction of antibiotics used in the dairy cattle population over the next three years (13).

Another probable explanation for the favourable situation of antibiotic use in dairy production in the two Nordic countries would be the efficient breeding programmes with disease/mastitis prevalence and/or cow milk somatic cell counts included in the breeding indexes.

What about future aspects on use of antimicrobials in food production?
Active and intense information to Norwegian and Swedish consumers has made them very aware of the risks associated with unrestricted use of antimicrobials in animal production. This, together with the increased awareness of farmers and veterinarians and restrictive rules from the authorities and food production industry, will probably keep the use of antimicrobials in animal production at a very low level in the future. The control of the disease registration systems is reinforced to give a safer quality guarantee on the controlled use of antimicrobials in food production animals. The veterinarians also are highly motivated to find other solutions to disease problems at the farm level, while focusing on more intense preventive actions in systematic cattle health programmes. The Norwegian and Swedish food industry thus is well prepared to meet the demands from the consumer groups for safe registration and control systems to provide a continuous guarantee of balanced use of antimicrobials in food production in the future.

* Formerly the Swedish Association for Livestock, Breeding and Production (SHS).

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About the speaker

Ms. Plym Forshell has been a veterinarian since 1974. She first practised in Sweden, where she was involved in dairy cattle health services. From 1991 to 1997, she was the head of the Department of Cattle Health Services at the Swedish Association of Livestock, Breeding and Production. As such, she was responsible for the central organization and local implementation of the national official control programmes on infectious diseases and member of an official expert group designing the Swedish national control programme for Johne's disease. Since 1998, she is employed by the Norwegian Dairies' Association at the Department of Milk Quality Issues and Cattle Health Services, with special tasks in the area of infectious diseases.

Managing for high quality milk

Léo Brisson
Milk Producer, Embrun, Ontario

I would first of all like to tell you a little bit about our dairy farm. The *Ferme Brissfrance Ltée* is made up of 250 acres of irrigated soil and 50 rented acres. We incorporated our farm in 1991, the shareholders being our son André, who graduated from the Alfred College in 1989, my wife and me. We transferred my wife's share to Julie, who is André's wife, in 1997.

Our dairy herd is composed of approximately 140 heads of Holstein cattle, 60 of which are lactating. The herd is registered and classified. The herd is under DHI with somatic cell count monitoring. It is artificially inseminated. Our composite BCA is 215, with an average of 9,313 kg of milk per cow per lactation. All of our animals bear our identification prefix.

I was asked to talk about the management techniques we use to produce quality milk. Our personal objective has always been to supply consumers with milk that we would ourselves drink. Bio-security is strictly regulated in our barn. Anyone who enters must disinfect his or her shoes and there is always a sign posted at the door of the barn asking visitors to do so.

We have had, for the past 24 years, free-stall housing with 110 stalls. We have approximately 55 to 60 lactating cows. The rest of the space is taken up by gestating cows and some dry cows. We put chopped straw in the stalls once a day and remove the manure twice a day. We sprinkle a small quantity of dehydrated lime on dirty or wet areas once a day. Our floor is slatted and equipped with small scrapers that remove the manure three times a day. There is no odour and the cows are always clean.

All of the cows receive a dry cow treatment at the end of lactation. A sample of milk is taken from each cow that shows signs of mastitis during lactation. Our veterinarian takes a culture to check the type of mastitis present and choose the appropriate antibiotic. If a cow is sick, we immediately give a first treatment and revise our strategy if the culture shows that another product would be more effective. Other cases are treated according to the culture results, approximately two days later. Cows suffering from mastitis are tethered in an adjacent barn and milked after the other cows.

Our dealer checks the milking equipment once a year. All rubber parts are changed at that time. The pulsators, vacuum pump, vacuum gauge, slope of the milk line as well as the presence of stray voltage are also checked. We alternate between two series of teat cup liners. Every two weeks, we disassemble the liners and the claws in order to wash them and especially to check whether they are in good working order or if there are holes or dirt between the mouthpiece, the barrel and the tube. At that time we change the liners and store the others in their original boxes. Each series of liners is used for approximately four months or 850 milkings.

The cows are milked twice a day in a double four milking parlor with automatic take off. Three people regularly do the milking, assisted by two temporary helpers. Two people do the milking at the same time. Four cows enter the parlor together and are immediately washed. We use newspaper and an iodine solution to wash the teats. The milking equipment is put on 30 seconds to one minute after the cows are washed. The equipment is automatically withdrawn at the end of milking. A teat dip composed of a 1% iodine-based solution is applied immediately

after milking. The liners are also soaked, two at a time, in a bucket containing an iodine solution to disinfect them between the milking of each cow.

Most of these methods were recommended to us approximately 30 years ago by a specialist from Kemptville College when he visited our farm during an episode of mastitis. Certain specialists now disapprove of some of these methods, but they still seem to work for us. I will describe to you a few examples of our somatic cell count results over the past years.

1990	70,400	1995	73,000
1991	44,100	1996	74,500
1992	59,000	1997	66,000
1993	46,000	1998	60,000
1994	60,000		

Since 1978, certificates have been awarded in Ontario for milk quality. The following criteria are applied:

1. Farm buildings must be of Grade A at all times; (according to the *Dairy Farmers of Ontario's* classification system).
2. No infraction must have occurred during the year.
3. No bulk tank must have been refused during the year.
4. To obtain the Gold Certificate, the average bacteria count must be 5,000 or less and the average somatic cell count must be 150,000 or less.
5. To obtain "regular" certificates, the average bacteria count must be 10,000 or less and the average somatic cell count must be 250,000 or less.

Between 1978 and 1987, we were awarded six "regular" certificates and four Gold Certificates. Since 1988, we have always been awarded a Gold Certificate.

Since 1990, Russell County's D. H. I. awards plaques for controlled herds having the lowest annual average somatic cell count. We were awarded a plaque seven years out of nine, with an average SCC of 60,000.

This does not mean that we don't have cases of mastitis. I believe that a herd that has a low somatic cell count is more susceptible to catch environmental mastitis because of a lack of immune resistance. Despiste this, specialists try to convince us that it is still more profitable to operate this way.

I believe we have to learn to live with a certain number of cases of mastitis within a herd. As Dr. Georges Fisher, a mastitis specialist at Kemptville College once said to me: "The only way not to have to deal with mastitis is not to have any cows".

About the speaker

Mr. Brisson is a dairy farmer in Embrun, Russel County in Ontario. He has played an active part in farm associations in the last 25 years. Over the course of ten years, he has been Vice-President, President and Director of the Ontario Agriculture Federation. He has been Secretary

and President of the regional dairy committee during six years and Group Supervisor for the 4-H during 6 years. Mr. Brisson has also been involved in the direction of the Embrun Coop, in the Hay Association, in the Farm Labour Pool and the Agri-East and Agri-West Coops of his area. He is currently a representative to Dairy Farmers of Canada for Ontario, region 1, which includes Prescott, Russell and Glengary counties. In his spare time, Mr. Brisson likes to go fishing or camping.